DOCUMENT RESUME

ED 287 470	IR 012 867

AUTHOR	Van Poucke, J., Ed.; Vansteenkiste, Marc, Ed.
TITLE	The Impact of Technology on Society and Education: A Comparative Perspective. A Pre-Congress Reader.
PUB DATE	Jul 85
NOTE	150p.; Publication prepared by the Dutch-speaking Society of Comparative Education as a contribution to the Congress of the Comparative Education Society in Europe (12th, Antwerp, Belguim, July 1-5, 1985). For the proceedings of this congress, see IR 012 868.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Viewpoints (120) -- Reports - Descriptive (141)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	Adult Education; Computer Assisted Instruction; Developed Nations; *Educational Technology; Elementary Secondary Education; Foreign Countries; Higher Education; *Information Technology; Inservice Teacher Education; Mathematics Instruction; Models; *Preservice Teacher Education; *Science and Society; Science Instruction; Second Language Instruction
IDENTIFIERS	*Belgium; *Netherlands

ABSTRACT

The five papers in this pre-conference reader were intended to stimulate discussion about the impact of technology on society and on education in general, and to provide some insights into the opinions of Dutch and Flemish researchers working in the field. In the first paper, "Information Technology in Education," Tjeerd Plomp addresses what learning about information technology should encompass in general compulsory education and in vocational education. The second paper, "Society and the Study of Science, Mathematics, and Technology," by Denis Kallen, discusses the complex issues involved in the development of educational policies in this area. In the third paper, "Information Technology and the Need for Schooling and In-Service Training for Teachers in Flanders," G. De Corte describes the knowledge of information technology needed by future teachers, the teaching of informatics in Flanders, the computer and teacher training in Flanders, and three types of inservice training. The fourth paper, "With the Computer as Alibi?" by J. Heene, examines changes in secondary education caused by the introduction of information technologies. In the final paper, "The Threading of a New Expertise: Teacher Training and Computer-Assisted Language Instruction (CALI)," W. Decoo provides a brief history of CALI, discusses obstacles to its introduction, and describes the elements of a CALI curriculum. Three of the five papers include reference lists. (RP)

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NGVO
Dutch speaking Society
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12TH. CESE CONGRESS
1-5 JULY 1985

THE IMPACT OF TECHNOLOGY ON SOCIETY AND EDUCATION

A COMPARATIVE PERSPECTIVE

A PRE-CONGRESS READER

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This publication was prepared by the Dutch speaking Society of Comparative Education (NGVO), as a contribution to the 12th CESE-congres - University of Antwerp - UIA - Antwerp Belgium - 1-5 July 1985

Typography: DIKR - UIA
Cover: Antia Muys, AV-Centrum, University of Antwerp - UIA
Printer: Slembrouck, Kortemark, Belgium

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THE IMPACT OF TECHNOLOGY ON SOCIETY AND EDUCATION

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Foreword

This reader consists of contributions written in conjunction with the 12th CESE-congres: 'The impact of technology on society and education. A comparative perspective', Antwerp, 1-5 July 1985.
This pre-congress reader is offered by the Dutch speaking Society of Comparative Education. The society is participating in the preparations of the congress and in this way hopes to draw attention to that important problem.
Many thanks to the authors and the redaction, all members of the Dutch speaking Society of Comparative Education, for their efforts.

Prof. J. Branger
President of the Dutch speaking
Society of Comparative Education
State University Leiden, the Netherlands

Foreword

I take great pleasure in presenting this book as an introductory document to the 12th CESE congress. It has been prepared by the Dutch speaking Society of Comparative Education to lay a solid ground for the work to be done at Antwerp during the congress.

Let me take this opportunity to thank all those who have contributed to this publication.

I hope that the 12th congress will convince many educationists form European countries and from overseas, and turn out to be a form of exchange of views and experiences concerning a theme of high comparative relevance.

Prof. Dr. W. Mitter,
President of the Comparative Education Society Europe
Frankfurt a. Main - F.R.G.

Introduction

The following model can be used as a starting point.

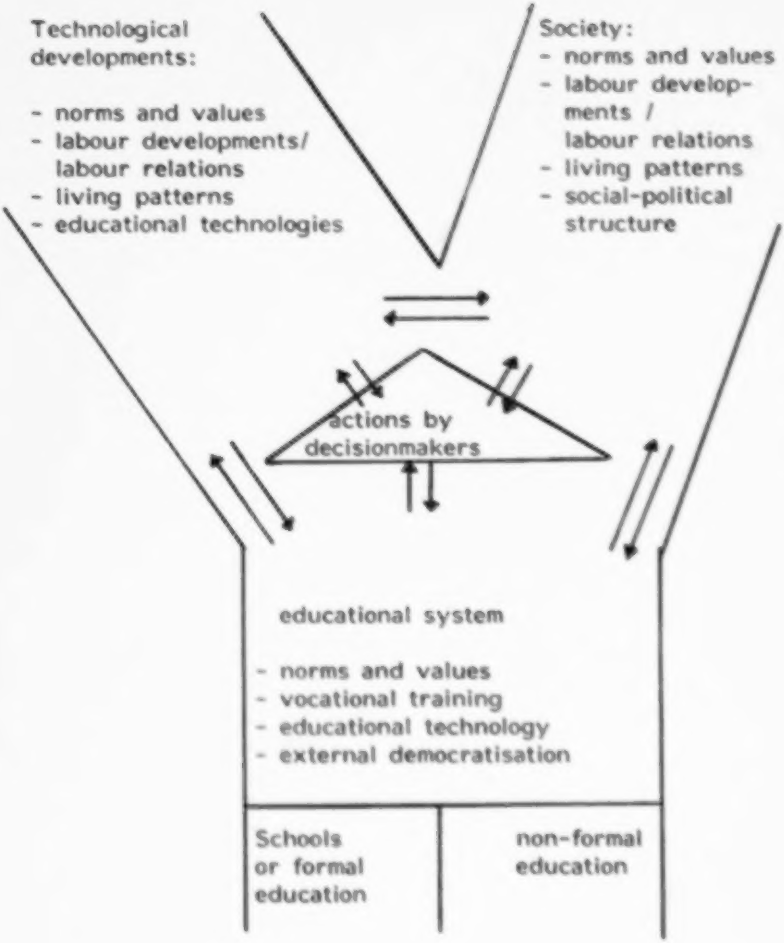
Technological
developments:
- norms and values
- labour developments/
labour relations
- living patterns
- educational technologies
Society:
- norms and values
- labour developments /
labour relations
- living patterns
- social-political
structure
actions by
decisionmakers
educational system
- norms and values
- vocational training
- educational technology
- external democratisation
Schools
or formal
education
non-formal
education

figure 1.

This model expresses the interaction that exist between society, technological developments, education and the policy to be pursued. This interaction is also expressed in the title of the C.E.S.E.-conference.

A summary of the technological developments in the eighties becomes necessary. Only after analysing what is new since the second world war and after making clear what a technological development really is, will it become possible to make a prediction about the future.

Looking at the potential influences of the new technological developments on society, it will be obvious to look at topics such as labour market, spare time and civilians living patterns, values and norms.
The possible influences of technological developments on education involve many different problems. There is an influence on institutional education, with problems specific for general education and for vocational training. The area of informal education is becoming more important and shows specific possibilities and dangers. And of course the influence of the computer on the micro-level of the classroom practice is at the moment certainly the problemfield most intensively studied. The more those evolutions are becoming clear in society, the greater the need to prepare teachers to cope with these new technologies in classroom practice.
Without losing our enthusiasm for educational innovation, we always have to keep in mind the restrictions and risks of technological developments. The possible negative consequences for society, for interaction between individuals and groups, and between industrialised and developing countries. Since developing countries have their specific technology and since it is not clear if the import of western new technologies is the right way to real development.

The different contributions of this reader are intended to stimulate the discussion about the impact of technology on society and on education in general, it hopes to give the reader a notion of some Dutch and Flemish scientists' opinions working in the field.

J. Van Poucke
M. Vansteenkiste

INFORMATION TECHNOLOGY IN EDUCATION

Prof.dr. Tjeerd Plomp
Department of Education
Twente University of Technology
Enschede, The Netherlands

1. Introduction

2. The changing society

3. Information technology (IT) in education
   3.1. Learning and teaching about IT
   3.2. Learning and teaching with the help op the computer
   3.3. Learning and teaching trough the computer
   3.4. The computer as a tool for organisation purpose

4. IT in general compulsory education

5. IT in vocational education

6. Concluding remarks

1. Introduction

When talking about information technology (IT) in education it is important that there is no misunderstanding about what we mean by information technology and more generally by technology.
Galbraith's definition of technology is generally accepted. He states that technology is 'the systematic application of scientific or organized knowledge to practical tasks' (Galbraith, 1967, p.12). Starting from this, we may define information technology (IT) as the application of scientific and technological knowledge about storing, retrieving and processing of data for the purpose of gaining in order to satisfy needs. It is commonly accepted that the term technology is not only referring to the specific knowledge which can be applied, but also to products, machines and instruments which are produced based upon scientific and technical knowledge. This means that IT refers not only to the knowledge about or the techniques for distributing and processing data via TV-channels, satellites or computernetworks, for example, but that those 'things' are very often also called examples of information technology. In most situations this twofold use of the term is not causing any trouble.
As a consequence of recent development in micro-electronics, computer design and communication technology, IT has changed so drastically that many people are speaking of new information technology or technologies, when referring to the instrumental aspect of it. However, in this paper we will stick to the use of the general term information technology (IT), because this is used as the central concept in the theme of this symposium.
In this paper the changing of our society towards an information society is shortly discussed in section 2. This will serve as a context for a description of possible applications of IT in education in section 3. In that section a restriction discussion will be restricted to learning about IT in general education (section 4) and in vocational education (section 5).

2. The changing society

Several authors, e.g. Toffler (1980), Naisbitt (1980) and Hãfner (1981, 1982) have argued (in different styles), that our society is changing from an industrial society to an information society. This means a society in which most of the people are working with information rather then producing goods, and in which information has become an important commercial product.

Characteristic for the changes in our society is that many human activities, manual as well as cognitive, are or will be taken over by information technology systems. Some examples from business and industry, which illustrate this proposition, are:

- manufacturing skills are taken over by computer controlled machines (robots);
- most of the proces control in e.g. chemical and steel industry is nowadays done by processing machines;
- in development and construction, computer aided design and computer aided manufacturing are applied largely;
- in many companies, such as insurance companies and banks, business handling systems and electronic money transfer systems are already replacing clerks and some of the middle management;
- in administrations, computers and data banks have taken over the role of communication and accounting: videotex systems and computer networks are used for business mail, while book-keeping and text processing machines are already taking over the workload from human beings.

Häfner (1981) rightly concludes that the informational environment in the eighties will cause a new balance of storage, retrieving and processing of data between human beings and machines.

Besides these (and other) examples which are illustrating that in business and industry jobs are vanishing and (presumably) fewer new jobs are created, the influence of IT is already manifest in existing jobs and will become more so. Just two examples as illustrations: the use of wordprocessors in the work of secretaries and the use of interactive videosystems by sales people to show specific features of new products (e.g. already applied on a large scale by the automobile industries in the USA).

We may conclude that mainly because of economic arguments such as competition, cost-effectiveness, and pressure of the computer and communication industry, business and industry are demonstrating a 'natural affection' towards IT and its applications.

To complete this picture, we have also to take into consideration the homes. Things are usually happening in the households quite naturally. This is also true with respect to information technology as we have experienced in the last decades: television with distance operation, automatic washing machines, a variety of computer games and, more recently, microcomputers have found their way into our homes without problems. In this perspective it is not surprising that toy manufacturers in the USA are the largest buyers of silicon chips (Hawkridge, 1983). Given the natural development of these processes we may expect further development in the homes in the near future, such as individualized use of IT (e.g. pay-TV, interactive access to databanks) that will be available via cable, video recorder and satellites, or interactive videotex systems, combining the TV-set, the home computer, central computers and centralized data storage via telephone lines. All these developments will also greatly enlarge the possibilities of taking part in educational activities in a variety of individualized settings outside the traditional schools.

The role of education

What will be or should be the role of education in this area of information technology?
Schools, as the places where traditionally most of education takes place, are less open systems than the world of business and industry or the homes. A consequence of this fact is that develoments in the schools are taking place less naturally or at least at a much slower pace. This is to a large extent due to the organizational and budgetary structure of our educational systems which lack the mechanisms for an alert and quick response to the developments which are taking place in the world outside the schools. Yet, the schools, where students have to be prepared for their future role in our society, should react to the IT developments in our society. The changing balance between human and automatic information processing, of which examples are described earlier, is asking for a new approach to and a new plan for education. The fact that many manual and cognitive skills are being taken over by machines will - if education does not change - result in a discrepancy between the goals for which students are educated and the skills which our society demands of school graduates. Häfner (1981, 1983), speaks in this context of a crisis in education.

What should be done to overcome this potential crises in education? How is it possible for education to continue to fulfil its tasks in the future, viz. to prepare people for their future functioning in our society? One thing is clear: neglecting IT will not be allowed. It is not possible either to address the question whether or not computer, or IT generally, should be introduced in education. It is no longer an issue, because computers are already used in many schools. The main question to be answered now is: how should schools react to their changing information environment? The possible answers to this question will depend on how schools, or more generally our educational systems including national, regional and local governments, perceive their mission in our society and on how they believe they have to respond to developments in our rapidly changing society.

3. Information Technology (IT) in education (*)

A categorisation often used to describe possible applications or uses of IT in education is:

A. Learning and teaching about IT,
B. Learning and teaching with IT, espec. the computer.
C. Learning and teaching through IT, espec. the computer.
D. The computer as a tool for organizational purposes.

Before describing briefly these four applications, two remarks have to be made. Although IT encompasses more than computers, e.g. also interactive videotex systems, the present applications in education concern almost exclusively the computer. We therefore will use in this and the following sections learning with and/or through IT interchangeably with learning with and/or through computers. This does not hold for learning about IT, which comprises more than learning about computers, as will be explained later on in section 4. Further, in practice the distinction between learning 'about', 'with' and 'through' the computer will not be as clear as in our analysis; very often mixed forms of applications will be found.

(*) The sections 3 till 6 are largely based on the reports, which the Advisory Committee for Education and Information Technology (AEIT) presented to the Dutch Minister of Education and Science (AEIT, 1982, 1984a,b).

3.1. Learning and teaching about IT

Information technology refers to a set of knowledge domains, all of which have to do with automatic information processing or the processing of data with the help of machines, such as informatics (computer science), micro-electronics, and telecommunication.

Information processing, also by means of computers, is a purposeful activity and can change drastically if its purpose changes. Often information-processing is ludicrous or meant for leisure. But often its purpose is exploration: e.g. acquiring knowledge, diagnosing probabilities or checking hypotheses by computer based calculations, simulations, learning, etc. Information processing can also be used for controlling and directing processes: almost all human activities and almost all functioning of machines, systems, processes and organizations are directed and controlled by data, nowadays frequently automatically processed.

Learning about IT will in principle mean learning about all its knowledge domains and all its applications. What will be taught and what will be learned is dependent on the age and the level of the students and the type of school. For example, a university student in computer science will learn about IT by studying programming languages, computer architecture and other parts of computer sciences. On the other hand, a student in the middle vocational (technical) school will study technical applications of IT, while a student in the lower grades of general secondary education will learn about IT by learning core principles of algorithmization and programming and by gaining an understanding of the major applications of IT in our society. From these examples it is clear that this application of IT in education needs further elaboration, which will be given later on.

3.2. Learning and teaching with the help of the computer

Characteristic for this application is the use of the computer as an aid or a tool in the learning and teaching process. Here, the computer is used in a way similar to the already existing resources in education, like blackboard, calculator, encyclopedia or laboratory equipment. Examples are the computer as an aid in spelling, in sorting, storing and retrieving data, in generating data and displaying them graphically, in creative writing (wordprocessing), in testing, etc.

In these cases the computer is used for only one support function or type of application at a time by either the teacher, the pupil, or by both.
The computer can also be used multi-functionally: this means that in a computer program more than one of the possible support functions of the computer will be used. In this way learning with the help of the computer evolves gradually to learning by means of or 'through' the computer, which is the next application we will desribe.

3.3. Learning and teaching through the computer

Characteristic for this application is that the teacher delegates 'teaching intelligence' to the computer. The teacher leaves to the machine certain decisions about the courses of the (individualized) teaching-learning process, at which information about the progress of the pupil is used. Yet, the ultimate decision about the use of the computer remains mostly in the hands of the teacher. In this type of application three functions of the computer can be distinguished:

- the computer as a teaching machine: the student learns in interaction with the machine; the computer controls the learning process and directs the presentation of new subject matter;
- the computer as a testing machine: the result of testing can be that the computer will present additional instruction or other test items; the testing can be either for diagnostic use or for grading;
- the computer as a monitoring machine: depending on the results of teaching and testing the system directs the student to a new part of the course or to the earlier or additional instruction.

3.4. The computer as a tool for organisation purposes

This application is referring to the use of the computer for administrative purposes (financial, personnel and student administration) as well as for organizational goals (e.g. time tables, surveys of progresses of students).

The last application of computers in education will not be discussed further, because it is beyond the scope of this paper.

Considering application 3.3.: learning and teaching through the computer, one must say that an application of this type of multi-functional use of the computer is not to be expected on a large scale on a short term. This application asks for very complex software, in combination with more complex, and therefore expensive hardware. Moreover, this type of computer use can have drastic consequences for the role of the teacher, the learning of the student, the organization within the schools and the classrooms, and teacher education.
On all these aspects, much research and development work is needed before a large scale implementation of this application in education can be justified.
All these arguments lead to the conclusion that this application must have a low priority when thinking of a short term policy for the introduction of IT in education.

An ongoing OECD study provides us assistance for a further elaboration of applications 3.1.: learning about IT and 3.2.: learning with IT, espec. computers. In analyzing the forces underlying the technological demands forward for education, the following arguments are put forward introducing IT in education (OECD, 1984):

1. The needs of the economy: to produce specialised manpower.
2. The need to prepare the young to be functional in a society permeated with IT, by giving them also a basic education in IT.
3. The improvement of the teaching/learning process: IT adds new powerful tools to education, by which its quality and effectiveness can be improved, especially low achievers and gifted may profit from this advantage.

The third argument refers to application 3.2. about the use of the computer as an aid in education. We will not discuss this application further, only for reasons of limiting the length of this paper.
In considering the two other needs (arguments 1 and 2) one can conclude that both are referring to the application of IT in education, which we have labelled with 3.1.: learning and teaching about IT. The 'need of the economy' is referring to learning about IT in vocational education, which will be further discussed in section 5. The second need is dealing with the general preparation of all pupils to be functional in our society. Considering the preparation of all pupils leads us to the question of what place learning about IT should have in compulsory education. This will be discussed is section 4.

4. IT in general compulsory education (*)

Before talking about a possible elaboration of learning about IT in general education, we need to pursue our earlier analysis a little further.

We have discussed how the information environment in our society is changing, which will result in a new balance of storage, retrieving and processing of data between human beings and machines. Many human activities (manual and cognitive skills) will be taken over by IT-systems. As it is one of the goals of education to prepare the young people for their future functioning in our society, this preparation also has to extend itself to the characteristics of a society permeated with information technology.

We may conclude from the prospect described earlier, that a characteristic of the so-called 'information society' is the presence of large numbers of data, which can easily be made available to individuals via IT-equipment. However, the availibility of data does not imply automatically that one has information at one's disposal.

The drawing of information from data (or messages) is a goal-oriented activity. There is a fundamental difference between data or messages at one hand and information at the other. This difference can be learned from the description of these terms.

- 'data' = facts, from which one can draw conclusions which may lead to the solution of a problem (e.g.: the inflation rate in FRG in 1983 was x%);
- 'message' = an objectified communication or text, physically recorded, e.g. a text in a newspaper or on tape (e.g.: the Ministers noticed that inflation of x% is too high and that the policy of the government need to be changed);
- 'information' = the meaning or interpretation which the receiver of data or message(s) attaches to them (e.g.: the interpretation which the receiver of the message about the x% inflation attaches to it).

(*) This section is largely based on a second report which the Advisory Committee for Education and Information Technology (AEIT) presented to the Dutch Minister of Education and Science, March 1984 (AEIT, 1984b).

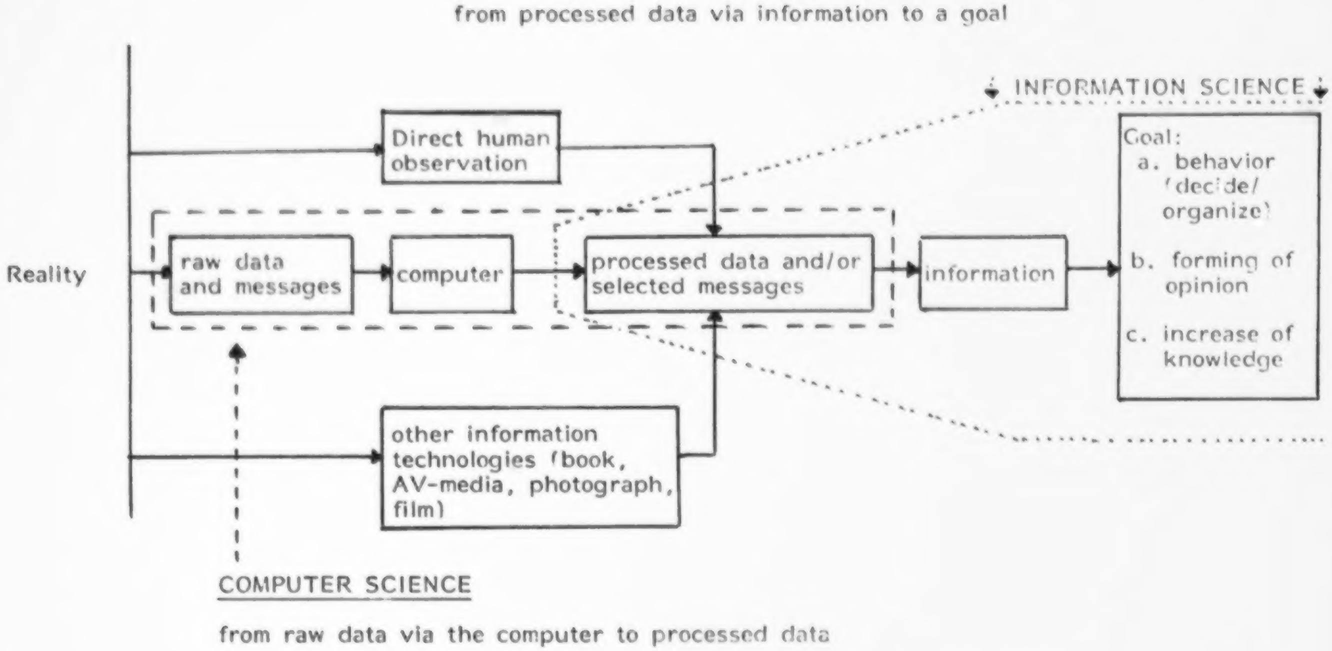
from processed data via information to a goal
INFORMATION SCIENCE
Reality
Direct human observation
raw data and messages
computer
processed data and/or selected messages
information
Goal:
a. behavior (decide/ organize)
b. forming of opinion
c. increase of knowledge
other information technologies (book, AV-media, photograph, film)
COMPUTER SCIENCE
from raw data via the computer to processed data

Fig.1: The relationship between information science and computer science (from AEIT, 1984b)

From the preceding it may be clear that there is no direct causal relation between the computer as processor, manipulator and retriever of data at the one hand and information as the meaning or interpretation which one may attach to the available data at the other side. One can speak of an instrumental relationship between the computer and information, i.e. with the help of a computer one can derive information from data and messages. (See figure 1).
The relationship between information science and computer science is complementary. From the angle of information science one can indicate which processed data or messages are needed to provide information for a certain goal. From the angle of computer science one can indicate how the computer, or more general information technology, should be used to produce from the raw data and messages the desired data and messages.

Let us now return to the central question of this section. If education has to prepare people for their future functioning in our society, what could then be the place of IT in education?
We have seen that our society is changing as a consequence of the developments in IT. Routine work and processes will be automated; the job market will change; the prestige and the necessity of certain types of knowledge and skills will diminish. People not only have to learn to live with more free time, but also have to be prepared for lifelong learning. Our society is becoming an information society. Many people believe that we are dealing with a change in our society which is comparable to the discovery of the printing in the 15th century. Only the speed with which IT makes its influence felt, is much faster.
The present developments are also threatening to some extent. Many people fear that the speed of the developments will exclude the interests of the non-experts or those citizens who are not involved in this process and that they will no longer play a role. In this context, people refer to problems of 'privacy' and of the 'control' of the management and supply of information: who will decide which data will be stored and where e.g. in hospitals, banks, insurance companies, tax offices, local authorities? Who will decide which data will be accessible to whom. How may data banks be combined into a network? Every citizen will also be confronted with these aspects of the information society.

This brings us to the role of compulsory education. With approval I would like to cite from a 'white paper' of the Dutch Minister of Education and Science (Informatics Stimulation Plan, January, 1984) in which he states that education not only has to create 'human capital' to strenghten the market sector (as discussed in the following section on vocational education), but also has as its goal the familiarition of all citizens with information technology.

This is a plea for some basic education. Not a basic education in computer literacy in the sense of learning some programming skills and how to operate the (micro)computer. Such a narrowly oriented education cannot contribute to a real understanding of the characteristics of the information society. From the first part of this section (see e.g. Fig.1) it may be clear that, when talking about a basic education for everybody, I am referring to basic skills about the field of information and computer science including the underlying knowledge. Given the fundamental changes in our society and given the new balance of storage, retrieving and processing of data between human beings and machines, we then have to master the skills and knowledge which are a necessity for responsive functioning in the information society.(*)

A first operationalization of these skills and knowledge is given by AEIT (1984b):

a. The selection, production, collection, storage, processing, retrieval and distribution of data and messages given a certain problem or defined need for education, with or without the help of a computer;
b. The drawing of information from data and messages;
c. The assessing of the reliability and the precision of data and messages and of the validity and relevance of the drawn information for the given problem;
d. The principles of the hardware and software architecture;
e. The disign of algorithms and the principles of programming.

(a, b and c refer to information science; a, d and e to computer science)

(*) It is important to state here that the preparation for the so called information society implies more than just learning about IT. It also has to imply issues like the possibilities of self-realization and preparation for lifelong learning in a constantly changing society.

Of course, this list can be elaborated in such a way that it will become the list of topics for a curriculum for IT-professionals. However, to get a useful content for universal basic education in IT, it should be elaborated in such a way that it can be an integral part of a school curriculum in which every pupil will participate, i.e. part of compulsory education.

For several arguments, the comprehensive (or junior high) school will be the best phase in education to learn about IT. Not only is this age group accessible for new facts and things worth knowing, it can also provide for a preparation for continuing education, either vocational or general, which is very relevant given the changing character of many jobs.

It is beyond the scope of this paper to discuss all aspects of implementation of this new universal basic education, such as the size, the place in the curriculum (separate course or not), the further development of the content, the problem of getting every pupil (girls as well as boys) involved, the teacher training component, the software development and the hardware supply. In the Netherlands, these questions are being studied in a project from 1983-1985 in which 100 schools are taking part.

5. IT in vocational education (*)

In information technology as such three fundamental parts or aspects can be distinguished: hardware, software and applications.

- Hardware consists of computers with their peripherals, micro-processors (more generally micro-electronics), computer networks and interfaces (e.g. sensors).
- Software consists of operating systems, interpreters, standard programs for datafiles and databases, procedures (the human component in information systems), programs for specific applications such as the collection and processing of data e.g. for stock administration or for trends in blood pressure.

(*) This section is largely based on a report which the Advisory Committee for Education and Information Technology (AEIT) presented to the Dutch Minister of Education and Science, March 1984 (AEIT, 1984).

- Applications consist of hardware and software which perform a specific function, usually as parts of a larger system. Many examples can be found: in intensive care units in the health sector, in laboratory automation, in automated hotel administration, in salary administration, in food distribution systems for cattlefarms.

None of these three fundamental aspects can be considered while neglecting others. Vocational education which restricts itself to one or two of these main points would fail its mission. Yet, certain sectors or programs within vocational education may differ in degree of emphasis on a certain aspect.

We have visualised the three aspects in Figure 2.

The upper part indicates all possible applications, while the lower part refers to either hardware or software. The inner area of this figure can be conceived as all possible IT-topics which can be taught in vocational education to prepare students adequately for their future professional life. Pints which are in the upper part refer to specific applications of IT in technical professions, agriculture, administration, health, etc. Points more to the left in the lower part refer to topics in which great emphasis is laid on the design and development of hardware and little to the other aspects. The reverse holds for points more in the right lower part, where the emphasis is much more on the design and development of systems software.

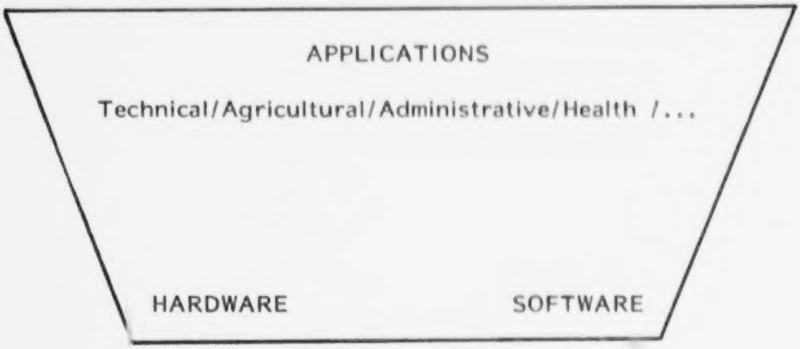

Fig. 2: The three aspects of information technology.

If we understand be IT-education all the teaching (and learning) which pertains to IT, then we may learn from the figure that not all vocational IT-education can be the same. A first distinction we can make is between education of IT-users (end-users) and of IT-professionals.

Education of IT-users

Most students in vocational education will not get a job as designer or developer (or maintainer) of hardware and software systems. For them it will be sufficient to become capable and responsive users of IT in their profession whether it will be in technical fields, administration, health, social welfare, agriculture, shopkeeping or others. Because IT will be an integrated part of a job or a profession it is important to teach IT not separately from job preparation. Therefore all (or almost all) courses concerned in job preparation should deal in an appropriate way with the application of IT on users level. This IT-user education should strive for the following goals:

- Having knowledge about the meaning of IT for the particular sector and ability in handling the most important and characteristic applications;
- Being able to consult with IT-professionals and to judge their proposals;
- Understanding the societal consequences of IT.

For this type of IT-user education it is necessary to modernize the curricula of all sectors in vocational education to develop relevant software, to bring the ability requirements of teachers up-to-date and to provide for adequate inservice training of teachers.

Education of IT-professionals

We have seen earlier that in business and industry many new jobs are created which are concerned with design, development and presumably also the maintaining of hardware and software systems. Generally one can distinguish here between two types of educational goals, viz. product innovation and production innovation.

Product innovation is concerned with the improvement of instruments, equipment and machines or with the design and develop-

ment of new ones. IT-professionals in this field will be the designers (and maintainers) of advanced hardware and software systems based upon the application of micro-electronics, control theory and computer design. As systems designers they will study topics near the baseline of Figure 2, very often they will hardly be interested in applications.
Production innovation comprises IT-applications, which are directed at a better functioning of production machines as well as processes making those cheaper, and with less dropout. The technical aspects of these applications concern the automatic control of machines and processes. They are known as computer aided design, computer aided manufacturing, numerical control of machines, process control and robotics. There will be an increasing demand for professionals who are competent designers of the types of IT applications.

Both types of IT-professionals need special curricula which may partly consist of existing ones and partly of new courses of computer science and informatics. The curriculum for product innovators, i.e. for builders and maintainers of hardware and software systems has to contain courses in micro-electronics, control theory, computer science, informatics and supporting theoretical and practical courses. The production innovators, i.e. the designers of IT-applications, need in their curriculum a fair mix of courses just mentioned and courses in their field of application, which can be mechanics, administration, agriculture, etc.
It is clear that next to the development of new curricula, courses and software, new teacher requirements and certifications have to be formulated followed by an adequate teacher training program and a suitable provision of hardware for schools.

Finally, we are able to refine Fig. 2 with the different manifestation of IT in vocational education. The sectors represent IT-users and both types of IT-professionals (see Fig. 3).

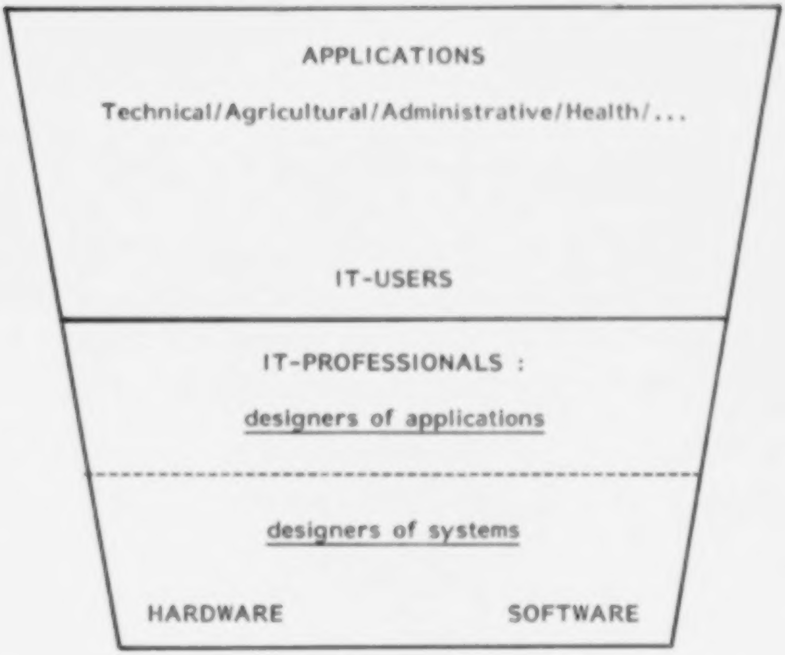
APPLICATIONS
Technical/Agricultural/Administrative/Health/...
IT-USERS
IT-PROFESSIONALS :
designers of applications
designers of systems
HARDWARE
SOFTWARE

Fig. 3: IT in vocational education

6. Concluding remarks

This paper deals with only some aspects of the application of IT in education. Attention is given to what learning about IT should encompass in general compulsory education and in vocational education. In many countries (see e.g. OECD, 1984) equal or more importance is given to the application which can be characterized by 'learning with the computer'.

But even the topic of learning about IT is not discussed exhaustively. As stated earlier, aspects like the place in the curriculum, the operationalization of the general goals into course content, the problem of equal involvement of all pupils, courseware development etc. are not discussed. A first elaboration of these can be found in the reports of the Advisory Committee for Education and Information Technology (in Dutch, see references). Another source for 'learning about IT' for general compulsory education is Van Weer (1984), of which an English and a German version is published.

References

AEIT (Advisory Committee for Education and Information Technology), Learning about information technology: a necessity for everybody. The Hague, 1982 (in Dutch).

AEIT, Information and computer science: about the content of an equipment for 'informatics for all'. The Hague, 1984a (in Dutch).

AEIT, Information technology in middle vocational education. The Hague, 1984b (in Dutch).

Häfner, K., Challenge of information technology to education: the new educational crisis. In: R. Lewis & D. Tagg (eds.): Computers in education. Amsterdam: North Holland, 1981, p.525-531.

Häfner, K., Die neue Bildungskriese. Basel: Birkhäuser Verlag, 1982.

Hawkridge, D., New Information Technology in Education. London: Croom Helm, 1983.

Information Stimulation Plan (Appendix on Education). White paper of the Dutch Government, January 1984 (in Dutch).

Naisbitt, J., Megatrends. New York: Warner Books, 1984.

OECD, The introduction of the new information technology in education: policy trends and developments in member countries. Report to be presented at the International Conference on Education and New Information Technologies. Paris, 9th-12th July, 1984.

Toffler, A., The third wave. 1980.

Weert, T. van, Modell-Lehrplan Informatische Grundkentnisse für alle Lehrer. Brussels: Association for Teacher Education in Europe, 1984 (also in English).

SOCIETY AND THE STUDY OF SCIENCE, MATHEMATICS AND TECHNOLOGY.

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Paper prepared for the standing
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Council of Europe - Strasbourg

Statement of the problem

- "Out-of-school" information and education
- SMT and the social sciences
- SMT in the educational career
- The case of vocational and technical education
- Girls and SMT
- SMT and employment
- SMT and future society
- SMT and the developing countries

2. The larger context

- The empirical analytical approach
- Child development
- SMT and the economic order
- The developing world
- Individual modernisation
- Integration between cultures
- Scientistic humanism
- Other cultural concepts
- Permanent education

3. Educational policies for SMT

- Guiding principles for educational policies
- Adaptation and involvement
- A new idea of culture
- Intersectoral approach
- Specific areas for SMT policy-making
- Consensus on basic issues
- Strategies

1. Statement of the problem.

SMT cover a complex network of fields of knowledge and application that is interwoven with the totality of scientific knowledge and with human existence as a whole. Subdivisions of these large fields of knowledge are necessary for analytical purposes - and for that matter also for teaching purposes - but the reality from which the analysis sets out and to witch its results must be related, is one and undivided. This applies to the individual as well as to society, to knowledge and research as well as to their applications. The need for a synthesis approach is particularly great when one deals with the role of SMT in education, where as in research the analytical approach must prevail. Where the role of SMT in education is concerned, one of the challenges that must be faced is to find in the curriculum the right balance between generalisation and specialisation. The child's own experience and observations plead for a generalising approach and for building bridges between the disciplines from the moment once separate treatment of the various disciplines has become inevitable. The structure of the sciences, and particularly that of the natural sciences, on the contrary, plead for ever more advanced specialisation. In society, SMT and their applications pervade every sector of social activity. Both in policy and in practice, the dividing lines between specialisations that characterise scientific research and analysis, have no meaning and need to be transcended. This applies not only to the divisions within SMT but also to the split between SMT and the social sciences. This pervasion is more and more becoming a two - way process: the social sciences increasingly affect science research and science policy, whereas the social sciences have since long been pervaded by the natural sciences. Whereas in the 1960's "science policy in the OECD counties was considered as an independent variable of policy, only loosely related to the social and political context" .... nowadays "policy for science and technology is only one element of overall public policy" and "it is essential that its links with other areas of government action directed towards the same ends be clearly understood.(1) It is now widely accepted that the frame of reference for research, teaching and policy - making for SMT cannot any longer be confined to the protected realm of the scientific disciplines. It follows that

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1) Science, Growth and Society:A new perspective.OECD,Paris 1971, pp 45 and 47

discussions and decisions relating to SMT and SMT policy are not anymore the privilege of experts of the SMT disciplines, as they had been until at least the early 1960's. Since, there has been a breakthrough towards demystification and politisation of science, furthered by such matters as the nuclear issue, the environmental issue, the social and political implications of the large - scale use of information systems in public administration and in industry, to name only some of the most publicised topics. Science and technology are no longer "very well protected areas in which decisions could be made without forcing too difficult conflicts"(1). The development of science itself and its technological applications, but also the awakening of public awareness, have placed SMT in the forefront of the political debate and have contributed to making the place and role of science and technology in society into a political issue of the first order.

This political awareness appears on the whole to be greater among the younger than among the older generations and it is more present among the more than the less educated. These are additional reasons to place SMT on the list of priority of educational policy.

To non - scientists the "politisation" of SMT and the ensuing subordination of the related policy decisions to overall political priorities and objectives may by now seem a self - evident matter. It goes, however, against a longestablished tradition of uncontested pre - eminence of the SMT sector over all other considerations. The change in priorities is very often confined to electoral declarations and has on the whole not yet been substantiated in the reality of political decisions and of daily life. In developed as well as in developing societies, science and technology continue to function in many areas of policy and practice as autonomous forces, accountable to their peers, but to nobody else. The full implications of the subordination to overall social objectives are often not drawn. It is also true that non - scientists, out of ignorance, sometimes oversimplify matters, exaggerate risks or imagine secret conspiracies where none exist.

Nevertheless, scientists and politicians will have to live the fact that science and technology, and particularly policy decisions that affect the citizens' well - being are being discussed in public places and that decisions as to SMT must obey the rules of the democracies in which they function.

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1) OECD,o.c.p16

This implies more than that elected representatives have the last word. It implies that public opinion at large, the mass media, and even groups and institutions whose objectives may for the scientists not have the remotest connection with their work, are entitled to discuss SMT issues and their implications and to exert political pressure in order to obtain decisions that serve the common interest as they see it.

It is in the public interest that this debate between expert and layman be based on good information. The impetuous development of scientific research and of technological application has made this into a nearly impossible task. Action groups that have been established specifically with a view to influencing decisions pertaining to relatively narrow fields of scientific research and technological application soon find out that they need to train specialists if they still wish to be considered as serious discussion partners. Parliaments, political parties and trade unions dispose of their own highly specialised experts for dealing with SMT issues. The distance between these and the general public, and even between them and their politicians -, party -, or trade union colleagues increases inexorably.

Nevertheless the task of providing the "public" with sufficient information to exercise its democratic rights must be met if democracy is not to suffer. It has sometimes been suggested that the development of science and technology contains an inherent lethal threat to democracy. The nuclear sciences have been named as the field which is most likely to bring conflicts and incompatibilities into the open. One could in this context also refer to the dangers that the development of data processing techniques contain for democracy.

The relevance of the above considerations for the debate on the study of SMT lies in the fact that admittedly the foundations for adult knowledge and attitudes about SMT are laid in schools and universities but are confirmed and brought to maturity later in life. If the study of SMT ceases when young people leave school, their knowledge of SMT as adults is bound to remain fragmented and diffuse, apart from the fact that it will soon have become obsolete. Moreover, their attitudes risk becoming stereotyped into one of the two extremes: uncritical acceptance or unconditional refusal. Adult education in SMT is therefore an indispensable complement to the foundation work that is done in youth education. Further on in this paper the modalities of this neglected issue will be discussed more amply.

"Out of school" information and education

At the same time it needs to be recognised that education, whether of young people or of adults, is only one of the channels through which knowledge and attitudes are transmitted. In its generality this statement requires of no further elaboration. For some fields of technological application, however, out - of - school "education" probably holds the quasi monopoly. Young people obtain the virtual totality of their knowledge about the exploration of space from out - of - school sources. It seems likely that the same applies to many specialised fields of medical and scientific research and to many other fields of technological application. The mass media in general, movies and comic strips, but also popular science literature provide young and adults with a wealth of popularised but not necessarily false information.

In fact, the average pupil who does not go beyond compulsory schooling or does not choose a scientific stream in upper secondary school, may in school never hear of the most fascinating and politically burning issues of SMT. Moreover, it is not unlikely that he or she is not capable of relating out - of - school generated information and interest to SMT in the school curriculum. Of course, these curricula have changed over time, but on the whole there has probably been more stability than change. Pilot schools and experimental schools are alas not representative of the average school and the average pupil and most of SMT curriculum reform was anyway not conceived with the aim of giving the average pupil an understanding of society through the study of science.

Reference has already been made to the fact that SMT covers vast areas of knowledge and application of a baffling complexity and differentiation. It also covers a large spectrum of knowledge, insight and competences, ranging from what is understandable and accessible to everybody to what is perceived, understood and mastered by only a few of the world's most brillant minds. Reference has also been made already of the growing distance between the world of the SMT specialists and that of the general public. A recent French report showed that 77% of the French population esteem that scientific knowledge is not an indispensable part of their general culture. One may assume that the feeling that science is beyond their reach of comprehension plays a role in this attitude. It must of course also be acknowledged that in France, as in most continental European countries, "general culture" still has a humanistic connotation. Nevertheless, evidence such as this is diturbing.

If education is to play a role in preparing future citizens for their role as voters and as full participants in public life and debate, it must be possible to build bridges between "academic" and "popular" science, there must be a continuum between the various levels of SMT, and not unbridgeable gaps. The very fact that a large part of the population accepts that SMT is a matter for specialists reveals an attitude that is perhaps more difficult to change than the sheer knowledge level.

Where technology is concerned one must, as has to be done for science, distinguish between interest and insight. Young people's interest in technological achievements is immense. It does not need school in order to be awakened and maintained. It is stimulated and engendered by children's and young people's innate curiosity and their need to take things apart and test out their functioning as well as by external incentives from all sides.

From the above the conclusion must be drawn that the establishment of a stimulating interaction between the out - of - school SMT reality with which young people are so intensely confronted and educational SMT policy is one of the principal challenges that must be faced in educational policies for the future.

These views about science contrast with the image of the social sciences. Through their apparent relevance to the concerns of everybody and to everyday life and through their deceptive simplicity they have acquired a certain popularity, in spite of the fact that they have often surpassed the natural sciences in developing an inaccessible jargon of their own. Nevertheless, their "openness", the fact that they solicit the larger population to take an interest and sometimes to take an active part in their development and perhaps also the fact that their representatives more often than the representatives of SMT sciences take part in social and political life, contrast in the eyes of many young people with the image of the sciences. Moreover, the social sciences have increasingly become the custodians that must prevent SMT from negatively affecting the well - being of mankind.

SMT in the educational career

The role of SMT in the educational career of a pupil is a further issue that needs to be more closely scrutinised.

Whereas there is ample evidence as to the frequency and the socially selective nature of failure, grade repetition and dropout, there is little evidence as to the role that achievement in the various subject matters plays in this.

Undoubtedly, SMT, and particularly achievement in mathematics, play an increasingly important role in school curricula and in determining children's further educational careers. After all arithmetic is one of the three "R's" and is hence a key criterion for appreciating the attainment of the key objectives in elementary education. In secondary education, mathematics has become one of the most important instruments of selection and allocation.

It seems that this increased role has not been accompanied by an increased popularity. "It is generally the case that maths is more expected than desired", says the IEA Mathematics Study ("International Study of Achievement in Mathematics", Vol.1, p.282).

Science enjoys in the early years of schooling, if adapted to children's interests, a much higher popularity. But as science education moves on, more advanced levels of mathematics and higher levels of theoretical thinking and abstraction are required. At the higher levels of secondary schooling mathematics and science alike have for many pupils become subject matters that are necessary,but not particularly liked. A majority of pupils are furthermore no longer exposed to any significant amount of either science or mathematics when they have reached post - compulsory education.

For the great mass of the school population as they move on through the educational system the science and mathematics part of the curriculum become a "must" that opens for them the door to the most prestigious programmes at the upper secondary level and, later, to the more prestigious areas of higher education and professional activity. Science and mathematics, and the latter more particularly, have in school systems become the paramount instruments of selection whose role increases the further children move on and the more selective the elected group becomes. In many ways they have thus taken over from the classic languages. It may be, furthermore, that their role has become more decisive as the crude external differentiations at the transition from primary to secondary education, and within secondary education, were gradually broken down. In the subtle internal differentiation that characterises comprehensive education systems, such a selective role is difficult to identify and difficult to counter.

This does not mean that differentiation on the basis of performance in one or the other subject is to be banned. It is, however, generally agreed that it should be reduced to the utmost insofar as it is dependent upon socio-cultural variables. There is evidence that performance in mathematics is related to social background and equally for science achievement "home background is, as expected, a good predictor of the student's achievement" (Science Education in Nineteen Countries, IEA, Vol.1, p.299). Mathematics and science are, just as the languages, not "culture - free". It may be that they are less "culture - bound" than, particularly, the knowledge of the mother - tongue, but there is no doubt - as will be seen later in this paper - that home background plays an important role in SMT achievement. Already at the lower levels of education, i.e. in basic schooling, parents' own educational background and their field and level of professional activity are likely to affect children's performance in science and mathematics. Later, in upper secondary school, home background is likely to affect the quality of pupils' information about the right choice of subject - clusters that provides access to the more prestigious fields of study in higher education.

The case of vocational and technical education

The case of technology, and of teaching in vocational and technical subjects, is a different one. Because of the very meagre role that is attributed to technological education in the curricula of elementary schools, early interest and performance in technology play a negligible role in orienting pupils towards full- or part-time vocational courses. They go to vocational school not so much because they are motivated, but because they were found unfit to enrol in further general education, and often because they did not attain satisfactory achievement in mathematics and, perhaps, science.

Youngsters who are excluded from "long" upper secondary education have thus often become uninterested in mathematics and science and feel on the basis of their frustrating experience in basic education little inclined to turn toward SMT studies in later life.

The situation of technical education at the upper secondary level is a different one, although its prestige and the further educational and professional possibilities that it opens up differ strongly between countries. On the whole, however, it enjoys an increase in prestige and it is on the way to losing its stigma of being second choice after general education courses. It may in many cases - although this would not apply to all countries - attract young people who are genuinely interested in both the theoretical foundations and the practical applications of technology.

Girls and SMT

The educational career of girls in relation to study in SMT deserves high priority treatment. There is no concluding evidence as to sex differences in aptitude for studying SMT.(1) Nevertheless mathematics, science and technology, as subject matters in the curriculum, as options, sections or school types, as well as most SMT careers, are still considered typically "male" issues. The fact that girls' achievement and interest in, notably, mathematics and science is on the whole lower than that of boys (IEA studies) and that their participation in SMT studies once these have become connected with specific streams, schools, or facilities, is in most cases lower than that of boys, is no doubt overwhelmingly due to traditional role concepts that are firmly based in society and that are hence difficult to change by educational policies alone.

SMT and employment

Study of SMT relates, as all studies do, to the world of work and employment. The emplyment issue is for what concerns study in SMT a cause of growing concern. As long as advanced economies were characterised by continuing growth, there was a permanent shortage of scientists and engineers. In particular, technicians and skilled technical workers were in short supply. Still, a few years ago, the fall in numbers of students in science faculties was in some countries an alarming phenomenon. On the whole, however, the employment situation for SMT graduates has now dramatically changed. Shortages have in many cases and for many professions turned into surpluses.
The friction between quantity and quality of educated manpower on the one hand and the needs of the labour market on the other, was in the past smoothed out by a labour market with infinite absorption capacity and almost unlimited substitution possibilities. This is no longer the case. Frictions between

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1) Whatever differences have been found, e.g. in the perception of spatial relationships, are at a low degree of statistical significance.

supply and demand now are left unsolved and lead to massive frustration of young people who have been led to believe that at the end of their schooling a corresponding job is waiting. Surplus of the higher trained leads to pressure on the next lower qualified group whose jobs are often taken by the higher trained and who in their turn have to accept jobs at a qualification level below their training level. This is one of the factors that result in the young unemployed who have left school with a low degree of qualification being a particularly acute problem.

On the whole, school leavers with a low degree of general education and little or no vocational training have often become "unemployable". Poor performance and low interest in SMT may have played a role in their overall poor educational achievement and their failure to take up vocational training. These same factors may induce in many of these youngsters a negative and even hostile attitude towards further schooling and training and, more particularly, to taking SMT subjects in which they have failed in basic schooling.

SMT and future work

The implications of the present economic crisis on the study of SMT cannot be fully appreciated. SMT has been the driving force of economic growth. Science and technology have for a century been the new religion of the developed nations. With the onset of a new era their position will change. Forebodings of that change are visible everywhere. They range from dramatic revisions of national budgets at the detriment of science and technology to the refusal by small groups of young people of technological civilisation in favour of a return to nature.

Other developments, of a more positive nature, begin to manifest themselves in many places. Small - scale production methods are being favoured, and in fact tried out in many fields of manufacturing. Many people strive to learn the fundamentals of a number of trades in order to be able to repair and sometimes produce or at least assemble simple technical articles. There are many symptons of a new attitude towards technology and towards technology - dominated civilisation, more critical than in the past, but also more constructive.

The profound changes in value structures from which these new attitudes derive cannot but affect the study of SMT. Or, more precisely, the position of SMT in educational structure and curricula, the choice of students, the attitudes of parents and teachers, in short, every aspect of education policy and practice. This is also bound to affect science policy, and has already caused it to enter a period of uncertainty and even anxiety.

SMT and the developing countries

Finally, the evolution towards a new relationship between developed and developing countries, and between North and South, must be included in a reconsideration of SMT study. Young people are often acutely aware of the profound changes in the world order that this revision will imply, but their views are primarily based on value judgments and not on analysis. Here lies an opportunity for SMT study to build on genuine interest in SMT not as a relatively isolated group of disciplines, but in close interrelation with social, economic and political reality and thus to build bridges towards the social sciences.

The above contains no more than a first list of issues that need to be taken into consideration when discussing the role of SMT in education. It is not exhaustive and it lacks the analysis that is needed for valid conclusions as to an educational policy to be formulated. At this stage, however, it seems appropriate first to open up the discussion to a wide range of issues that has on the whole been ignored in the past.

2. The larger context

The larger context in which the above considerations have to be set is that of the role of SMT in the life of the individual and in society. This role has evolved ever since man has started to scrutinise the laws of nature and to shape his environment. Scientific research and technological progress have in the past centuries gone through a process of prodigious development. One of the dilemmas which man is now facing is that society cannot survive without further scientific discoveries and technological development, whereas at the same time this further development is becoming a threat to man and nature. In the recent past we have, for the first time since the early resistance against technological progress in the 19th century, been confronted with several serious warnings against further unlimited scientific and technological development. Now, only a few years after the publication of "Limits of Growth", and the start of the energy crisis, these warnings have been largely forgotten, but the awareness of the need for a new society and a new world order has remained. As a result, there is now a favourable climate for a reconsideration of the role of SMT in the life of the individual and in society on which a new policy for the study of SMT could be based.

The development of science has only been possible because of the curiosity of man and of his ability to understand the laws of nature and to tool it according to his needs. It would be interesting to draw a parallel between the development of science and that of the human mind, both in evolutionary and in developmental terms. It has often been said that as a result of the great complexity and the enormous degree of specialisation in the sciences, the times have gone when one single man could master the totality of knowledge accumulated.

The empirical analytical approach

The phenomenologists especially have criticised the predominance of the analytical approach that has led to a continuing process of further dissection of nature and living beings into their constituent chemical elements. Analysis, they argued, leads to explaining phenomena ("erklären"), but not to understanding and insight ("verstehen"). The fact that the whole is more than its component parts has been forgotten. Naked empiricism distorts reality and cuts it into fragments that each in themselves are without meaning.

Science teaching has for a long time been dominated by the empirical - analytical approach. It is true that modern concepts of science teaching have transcended this empiricism but the reality in the classroom has not always followed.

Child development

Too little attention has also been given in designing science curricula to the inner logics of child development. The young child is unable to isolate variables, his thinking is concrete and is based on the unity of his observations and experiences. Whereas in theory the stage of "concrete operations" (Piaget) makes at around age 11 to 12 place for the period of "propositional or formal operations", i.e. for a stage in which abstract thinking and deductive reasening make their appearance, many children's mind operate still for years predominantly according to the laws of the earlier stage of development. Hence a need to proceed only gradually, and for some children later than for others, to the introduction of empirical - analytical science.

SMT and the economic order

SMT and economic order are interdependent. The economic order of the developed world has been made possible by the development of SMT. A new economic order requires a reorientation of SMT, as new reorientations of SMT result in changes in the economic order.

Many established beliefs about the interdependence between science, technical application, production, economic order and socio - political systems have been put in doubt and have proved to be too simplistic. Economic power is no longer the only source of political power and of social privilege. The contours of thez "post - industrial" or "post - capitalist" society are, however, nor yet very clear. Neither have the concepts about a "new economic order" been sufficiently elaborated. We are in a period of transition and some countries are more advanced on the way to a new order than others. What seems certain is that SMT have lost their monopoly position in determing the rate and the nature of economic growth. New factors, and in particular new social and political forces have originated and have begun to influence the nature and the pace of development.

The SMT - "world" has not yet fully adapted to these new facts. The situation is therefore marked by uncertainty about the role of SMT in a future society in which economic growth is no longer the prime goal.

The developing world

The future of the developing world and of the relations between rich and poor, North and South, is another dimension of the SMT issue. It was already referred to in chapter 1. Apart from the direct implications for the teaching of SMT to which reference has already been made, there are more general aspects that need to be taken into account. SMT in developing countries depend strongly on that in the developed world. The former are, however, faced simultaneously with the issues that have concerned the latter in the successive stages of their industrial and economic development. SMT in the developed countries cannot ignore the dilemmas with which the developing countries are eventually faced. Neither can the rich countries ignore the fact that their own development largely depends on the raw material of the developing countries but that their policy in using these resources has inevitable implications for the latter's future development possibilities. The conclusion that is to be drawn is that the SMT issue can only be adequately dealt with on a world - wide scale and that this world - wide dimension must be present in the study of SMT throughout the educational systems.

Individual modernisation

There is another aspect to development that relates directly to SMT. The success of the development process depends to a high degree on the success of individual modernisation. The basis for modern attitudes and behaviour is to a large extent laid in school. This is particularly true in societies in which the values and attitudes held in family and community are strongly traditional. SMT in their turn probably play an important role in the educational upbringing of "modern man". However, this may be more a matter of learning values and attitudes than of the curriculum. These values and attitudes may be acquired more easily in SMT learning than in other fields of learning. If one, however, defines "modernity" in the diversified sense in which it has been done by A.Inkeles, and includes such criteria as "disposition to form or hold opinions on a large number of the issues not only in his immediate environment, but also outside of it" (p.21), other disciplines in the curriculum may be much more adequate instruments than SMT to achieve "modernity". "Enlightment" and SMT were long believed to be closely linked, but since the notions about "enlightment" have changed in favour of a concept that includes social awareness, readiness for social change, openess for new ideas in the socio - political fields, SMT have lost their monopoly in preparing for enlightment or modernity.

Integration between cultures

SMT and culture are readily connected since C.P.Snow exposed his ideas about the "two cultures". It may be that the gap between the literary and the scientific subcultures has narrowed since Snow wrote his essays. One can on the other hand now safely speak of the social sciences as of a "third culture". This third culture is nowadays not so much engaged in a dialogue with the scientific one, as Snow thought it had to be "in order to do its job", as it is in disagreement with it. One may on the other hand doubt whether the social sciences have done much to bridge the gap between the first two cultures. It looks sometimes as if they have been primarily concerned with building empires and developing linguistic codes of their own.

Scientific humanism

There are nevertheless also signs of a new integration between science and humanities. Edgar Faure has proposed the concept of "scientific humanism" in which are combined concern "with man and his welfare as an end in itself" and, on the other hand, the definition of the humanistic content "by the continuing new contributions of science to the field of knowledge and about man and the world" ("Learning to be", p.xxvi). Faure's report sees as the role of science and technology in education "to help the individual to control not only natural and productive forces, but social forces too" (ibidem). They are "to help man to develop a scientific frame of mind in order to promote the sciences without becoming enslaved to them". The Unesco report sees in scientific humanism a guarantee for the preservation of a new democracy, in which the dangers involved in scientific and technological progress are controlled, in which the alienation that they otherwise, if uncontrolled,would lead to, is combated and avoided. Education of the citizen in scientific humanism is the indispensable tool to achieve this aim.

Some scepticism as to these optimistic views about human motivation to learn and as to the advent of scientific humanism seems justified. Nevertheless, the concept of scientific humanism is of great value as it does away with the cleavage between the various cultures and proposes a cultural concept for scientists and humanists and for the developed as well as for the developing world.

Other cultural aspects

The educational concepts formulated in the context of the European Cultural Foundation's Plan Europe 2000 and in the Council of Europe's work on permanent education should equally be mentioned in this context. All these approaches attempt to portray, be it still in rough lines, the new culture of a "post - industrial society" in which the humanistic traditions of Europe are reconciled with its SMT achievements, and in which the latter are placed at the service of a democratic society.

Permanent education

It is not by chance that all these new cultural concepts are placed in the perspective of lifelong, recurrent or permanent education. Their realisation requires that a major if not the main, educational effort for achieving "scientific humanism" must take place not in initial schooling but in adulthood and hence in the framework of a policy for permanent education. In view of the educational policies that will be discussed in chapter V, the greatest possible stress must be laid upon this key principle.

3. Educational policies for SMT

To the complexity of the issue as it has been outlined above must correspond educational policies that enable to meet the variety of objectives to which SMT studies shall contribute. There cannot be one single policy for SMT. Such different objectives as the education of high level specialists and the preparation of future citizens call for different sets of policy measures. On the other hand it would be a mistake to conceive of unrelated policies for each set of objectives. It has been argued that SMT can no longer operate in isolation from other fields of knowledge and policy making, and that it cannot any longer claim a sanctuary for itself to which the non-initiated have no access. Equally, policies for the various levels and types of education interact on each otherand must therefore be coordinated.

It may seem superfluous to repeat such principles. But it must be remembered that they are rarely effectively respected in the reality of education policy.

Guiding principles for educational policies

From the considerations as to the role of SMT in the society in the foregoing sections of this report a number of indications can be deduced that must guide educational policies for the study of SMT. They are varying importance and relate to various sectors and levels of policy making. They are in particular:

- learning in school and outside school complement each other and must hence be related to each other in SMT policies and curricula.
- study of SMT must be based on the principle of the unity of knowledge. As a consequence, the SMT disciplines must be taught in a way that this unity is made visible in particular at the beginning and at the end of the analysis. This applies to the relations of the SMT complex with the totality of knowledge as well as to the inner coherence of the several disciplines within the SMT sector;
- theory and application are inherently related. SMT teaching in which this relationship does not continuously transpire fails its targets both for what concerns the general education of the citizen and his preparation for work and research.
- equally, the separation between mental processes and manual work and the assumption that the world population can be divided into these whose abilities destine them to the first and those whose destiny it is to occupy themselves with the latter are to be rejected;
- on accounts of principle as well as on account of the evolution of the world of work, education must provide a broad basic training that facilitates adaptability to requirements in work and in social behaviour at large. Equally, it must prepare for a critical and active role in shaping social and work conditions. Political issues and implications are in SMT studies not "out of bounds";
- SMT studies must reflect, and even be ahead of new thinking about the function of SMT in society. They must play an active role in preparing for such matters as small-scale production processes, soft technologies, priority for production methods that conserve the environment, and the like;
- SMT studies must reflect the high priority given in economic and social policy to the optimal, i.e. equitable, and full use of the available world physical resources;
- SMT studies must be guided by the aim to attain a more equitable distribution of resources between the developed and the developing countries. Research, production and consumption patterns must be revised in accordance with this aim.

The reorientaion of SMT studies along these lines requires thorough preparation through research, curriculum development, development of new teaching methods and preparation of teachers. This is an undertaking that is much more ambitious than the reform of SMT curricula that in many developed countries was energetically pursued in the 1960's. It also requires different volumes and types of resources. Above all, however, the modes of operation differ from those that were adopted when in earlier years mathematics and sciences curricula were being revised. Educational theory had very little to do with those reforms, and it may indeed be doubted whether it could contribute much. "If this view is accurate, the non-involvement of educationalists is understandable....Curriculum development appears to commence by the involvement of scientists working in groups of varying size, generally without educationalist support towards the production of curricula.... The second generation of projects appears to bring in an element of educational expertise primarily for the formulation of objectives and more formal evaluation... .. The third phase is one in which the curriculum is becoming individualised-either by curriculum units being generated in a school for its own needs, or by the central production of modules for individualised learning by students" (1)

The operation that is now required is a different one. Unlike SMT reform as it has been practised all over the world in the past, it must give priority to the education of the average child who is not going to be a scientist, an engineer or a mathematician. It must involve not only educationalists but all those who are concerned with the function of education in society. The new impetus has to come not so much from the disciplines and their representatives, but from the world outside the school. The rationale for the new programmes has to be based primarily not on the structure and the internal laws of the SMT disciplines, but on knowledge about the development on the one hand and on the broader social aims that are pursued on the other. This does not mean that new curricula are to be based on diffuse knowledge and information, but that educationalists on the one hand, "generalists", representatives from the world of work and from the social sciences on the other, must be involved throughout the process.

(1) Kevin keohane. An analysis of Science Education Research in European Countries, in: Research in Science Education in Europe, Ed.by Karl Frey a.o. Amsterdam 1977.

Adaptation and involvement

A second difference with the former curriculum development projects in science and mathematics relates to the fact that the process is no longer limited to specific curriculum development units that elaborate a model which is then, after minor adaptations, introduced in the schools of the countries all over the world.The process has now to be more diffuse and more "individualised". More diffuse to the extend that development of model curricula at one central spot would be counter-productive in that it would allow the involvement and commitment of schools and community, who would continue to be relegated to the role of consumers of ready-made products.
More individualised to the extend that specific expectations, conditions and needs must find their expression in objectives, curricula, and in the organisation of the learning situation. The ability and motivation to organise such individualised learning situations differ from case to case. Centrally initiated research and development work will remain needed. It would anyway not be in the national interest to let differences between regions or between schools become too great. Nevertheless, more than in the 1960's the accent needs to be shifted to initiatives taken at the base-level and to programmes and methods that are adapted to the needs of the users.

A new idea of culture

This requires more than the mere revision of existing curricula and the introduction of new subjects. The ultimate objective is to develop a new idea of culture that integrates the scientific and technological dimensions of our existence based on a large consensus and reflecting the full range of humanity's aspirations and concerns.

Intersectoral approach

In other words, education must not only reflect the development of SMT in society,but where possible take the lead in these developments. The difference with SMT curriculum reform as it was practised in the 1960's is that now the challenge is not so much that of modernising the curricula, but of redefining their role and function in the larger educational and social context. This task pertains to overall educational policy and not to the

SMT disciplines as such. Futhermore, this task requires involving other sectors of policy-making: culture and leisure, youth policy, economic and social policy. The implications for these sectors need to be analysed and the complementarity of policies in these various sectors to be defined.
It is believed that planning for such a fundamental overhaul of SMT policy must simultaneously operate at two levels: that of reconsideration of overall objectives and policies and that of goal-directed policy measures for specific strategic aspects of educational policy. The latter must help to bring the former overall change about and their effects must hence be judged in that perspective.

Specific areas for SMT policy-making

In the following, a number of these specific sensitive areas for SMT policy-making are proposed for more detailed discussion. The broader framework in which they must be placed has been outlined in the foregoing part of this chapter and in chapter 1 and 2. In discussing the following issues these larger and long-term objectives must constantly be kept in mind.

a. the structure of basic education - i.e. education untill the completion of compulsory schooling - and its effects on choice and motivation of SMT studies;
b. the place of SMT and particularly of general science and general technology in basic education;
c. the relationship between general and technical education in secondary scxhool and particularly at the upper secondary level.;
d. the inner coherence of the SMT disciplines and the dialogue between the Smt sector and the social sciences; the inter-disciplinary issue;
e. factors on which choice and allocation for SMT curicula and careers are based throughout the educational system;
f. learning about SMT in school and elsewhere: complementary or competition?
g. the place of women in SMT education;
h. teacher training;
i. SMT in a recurrent education perspective.

Consensus on basic issues

On each of these issues alternative policy proposals will need to be elaborated. This cannot be done, however, without taking a stand on the larger context as it has been indicated in chapter 2. There must, e.g. be consensus as to the need to involve closely young people and adults in the evolution of SMT and to enable them to judge about the policy issues that are involved. Ther must also be agreement as to the need to bring the several "cultures" together and to build bridges between, notably the natural and the social sciences. The importance given to the interdisciplinary issue depends on the views that are taken as to this. There must also be agreement as to the necessity to build bridges between SMT as part of general culture and SMT as high-level research and teaching issues.

In fact, the above means that there must be a minimum of agreement as to the concept of society, and notably as to the democtratic foundations on which all policy and SMT policy in particular must rest - and as to the ensuing need for changing educational policy.

Strategies

The second level on which consensus needs to be obtained relates to the strategies that are best suited to attain these objectives. At the verbal level at least, there is a growing agreement as to some of the most important measures that need to be taken. Examples are the recognised need for early general science and general technology in the curriculum, agreement as to the priority to be given to interdisciplinary teaching, and as to the desirability of bringing together theory and application, mental and manual processes, and thirdly, recognition of the need to formulate a policy on out-of-school learning on SMT and to develop its complementarity with learning in school.

Similarly for what concerns the implementation of such policies, however, it will not be necessary to start from zero. In many places initiatives have been taken, experiments carried out, new programmes developed, that translate these ideas into practise. What is lacking is a comprehensive policy of research and development work allowing the formulation of policies on the basis of the experience hitherto gathered and the identification of blank spots in research and development.

INFORMATION TECHNOLOGY AND THE NEED FOR SCHOOLING AND IN-SERVICE TRAINING FOR TEACHERS IN FLANDERS

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Conclusion

1. Introduction.

It is difficult to estimate the consequences introducing new technologies into education. Nevertheless, we would like to analyse the specific impact of the computer on the schooling of teachers in more detail.

The computer is penetrating all branches of society more and more.Therefore, since one of the main objectives of education is to prepare the pupils for functioning as well as possible in future society, the computer should get a chance in a justifiable present-day education.

One of the most important conclusions of the European report "Computer Education in Six Countries: policy problems and issues", (Cerych, 1982), is the fact that as many teachers as possible should become familiar with information technology in the shortest possible time.

It is important to keep in mind here that with the introduction of new elements into education - in this case, the computer -, it is not the pupils who are primarily concerned, but the teachers. They should first be familiarized with the possibilities and limitations of the new technologies, and should be able to check the extent to which these offer new useful possibilities for their educational task. Only when we have a certain view on this, can we talk about the introduction of these technologies into education. So, all teachers should have some knowledge of information technology, in order to be able to handle this information technology in a satisfying way when it becomes a part of education. The advantage of teachers knowing something about information technology is that this also enables them to refuse something when it comes.

Before introducing the computer into schools, the teachers 'interest ought to be thoroughly aroused first.This has to be built into the training as far as future teachers are concerned. As for present-day teachers, there is an urgent need for in-service training programmes. In this text the word 'teacher' is used, by which we mean all teachers of primary, secondary and higher - whether university or not - education.

2. The knowledge of information technology required for future teachers.

If present-day and future teachers want to function as well as possible within an education system embedded in a computer society, they should posses a certain basic knowledge of these new technologies. We can devide the knowledge and cognitive skills all teachers should acquire into the following categories:

- a basic education all teachers should aquire, making the teacher 'computer literate'.
- a supplementary education for teachers who will teach a subject on the theory of informatics (programming, system analysis,...)
- a supplementary subject-specific education for teachers who use the computer in their lessons (physics, languages,...)

We shall illuminate on these categories and translate them into an education programme.

2.1. A 'basic training in computer and education' for all teachers.

Our concerns here are the knowledge and cognitive skills all teachers should posses if they want to educate younger people in a justifiable and critical way in the present-day computer society. In general teachers should know what a computer is, what it can do, and how to use the computer at school.
In practice, this means that all teachers ought to:

- possess factual knowledge concerning computer terminology and the history of the development of the computer.
- be able to define problems and work out solution strategies.
- be able to read and write simple programmes and understand how a computer processes (these) programmes.
- be able to handle a computer (within an educational setting).
- discern the possibilities and limitations of a computer system in education, which problems can and which ones can't be solved with the aid of a computer.
- be capable of joining in the discussions about moral and social implications of the introduction of the computer into society in general and into the education system in particular.
- know where accurate and up-to-date information on computers and education is to be found.

It is important to keep in mind that you can only acquire knowledge of information technology by experiencing all sorts of matters yourself, not out of books or courses, but in various real situations. Making an acquitance with information technology doesn't merely mean that you learn to handle information processing systems, but above all that you learn to make critical use of its products, the data themselves. The possibilities

for storing data at small cost, and of recalling it over great distances, are becoming so large, that the value of merely processing data is decreasing all the time. As qualitative processing of information is of primary importance, the need for analytic cognitive skills is on the increase. After all, you can only operate a system if it has been decided beforehand precisely which data is needed to answer the questions you have conclusively. Having a lot of data doesn't necessary signify that you are well-informed.
Speaking in terms of a curriculum this means the following topics have to be dealt with:

a) computer terminology

An elemantary technological knowledge of a computer system is required. Naturally basic notions such as data, information and information-processing will be dealt with here. The basic components of a computer system and their specific operation and cohesion will have to be discussed. This part should be considered as an introductory, descriptive part that is necessary to understand the possiblities and limitations of computers, which will be dealt with in subsequent parts. Basic knowledge of some important terms of the computerjargon (floppy, chip, ROM, RAM, bits,...) gives the impression of 'belonging'. A short historic outline will stress the fast evolution within information technology.

b) Problem solving thinking and programming.

This part is very important as the techniques thus acquired are useful for all subjects and practical situations in daily life. Part of this sub-division is to let the teachers gain orienting experiences with: algorithmic thinking, modular structures (top-down development), solution strategy and systematic refinement of algorithms and programming in a protected programming environment.
To solve a problem you start from the full definition of the problem, then work out a solution strategy (by drawing up an algorithm or heuristics). This thinking process remains, for the time being, the exclusive field of man. To write down the results several techniques exist: organigrammes, flow-charts, pseudo code and Nassi-Schneidermann diagrammes. A structured solution is built out of the basic structures sequence (succession), selection (choice) and interaction (repetition). After all, with all this algorithms, except the recursive ones, can be represented. In this process ample attention is explicitly paid to schematizing. Furthermore for

the elaboration of a problem a top-down development always has to be chosen . With a top-down development a problem is 'solved' by dividing the 'large' problem into smaller, easier subproblems. This strategy can also be applied very efficiently outside the theory of informatics.

The developing of heuristics and algorithms is of course nothing new in education. The theory of learning problem-solving methods goes back to Selz, Langeveld and Kohnstamm (Germany-the Netherlands). De Block (Belgium, 1960; 168) basing himself on these theories, states that for the pupil learning to think consist of :'finding, through understanding varied application and integration, the methode for organisation and solution when struggling with varying problem situations.' In practice, this means that a pupil may not passively the contents of teaching, but he should get the opportunity of actively joing in, he should be gripped by the contents of teaching. The same objective emerges in learning about and with the computer.

As a second consequence of his definition of learning how to think, De Block states that what matters in schooling is not "knowing" but "being able to". A shift in accent from the static "knowing" to the dynamic "being able to" is indispensable. It is important to know where which information is to be found and how it can be recalled. De Block states as a third consequence that, in order to come to insight and to finding and actualising the methods of solution, the aid of a teacher is essential. This teacher, however, may not be "someone who gives lessons", but must be a "helper". This is also the case for education supported by a computer. The insights of educational theory which underlie the justified introduction of the computer into education are therefore not new, but are the actualisation of ideas of didacticians and psychologists of learning of old, an actualization we have to embrace with open hands. By programming we certainly do not mean merely generating small BASIC programmelines!It must be a continuation, with the aid of a machine, of the thinkingprocess we have just outlined . The fully elaborated solution strategy, written down in pseudocode or a flow-chart, is now "translated towards the computer". So this is merely a process of translation, without much creative contribution. Nevertheless, it is important to write and try out the simple programmes. Thus you quickly discover that the computer is nothing more than a stupid machine into which you have to spoon-feed everything, and with which you communicate, according to very strict rules.

c. practical use of the computer and software

Future teachers not only need to know how to use a computer-system (making connections with e.g. printer, monitor, T.V., supplying a printer with a new tape, paper,...) but also what kinds of software exist and what what can be done with them. As most people will never develop software themselves lateron, hence a comprehensive acquantance with general programming language is not necessary.Still, full use will have to be made of applied software (e.g. wordprocessing package or databank). Knowledge of informationsystems is also required, e.g.withdrawal systems such as videotext, teletext, automatic library systems, reservationsystems,....

d. practical usage of the computer in education of courseware

teachers should have experience with computer-guided education, with computer-managed education, and with the courseware specifically developed for these purposes (=educational software).By computer-guided education we mean that the computer is applied for imparting the facts, concepts and cognitive skills of the usual curriculum to the pupils. Computer-guided education makes use of less traditional methods such as "problem solving", "simulation", "dialogue and inquiry", "instructional games", but the largest part consists of "drill and practice", "tutorial" and "demonstration". With computer-managed education learning situations are not created, but the learning gets "managed". We're dealing here with the generating and analysing of tests for diagnostic usage;with the aiding and orientating of the pupils on the basis of the results obtained from the tests; with the storing and afterwards interpreting of the information on marks and the reporting of the improvements made to the parties concerned. A lot of emphasis has to be put on the evaluation of the courseware. Only very little high-class quality courseware is available on the current market. Both as to quantity as well as to quality the supply is small when compared with the demand. We cannot expect the individual teacher to develop the necessary courseware: the making of a softwarepackage for one lesson requires at least 100 hours of labour. The large amounts of energy and time spent on developing authorrial languages and - systems , have not turned out to be very lucrative. Authorial languages and -systems are meant to simplify and accelerate the creation of courseware so that each teacher could produce his courseware of his own. This goal has not been reached for various reasons. An individual teacher cannot develop high-quality courseware with it. Courseware is best been developed by programmers assisted by experts and didacticians.In this instance the traininginstitutes could play a coordinating role: for they have experts and didacticians at their disposal, and they are equipped with a number of micro-computers. The state support might turn out to be necessary.We can refer at this point to the situation in Great-Britain where at various universities, within the framework of the MEP-project, programmers make courseware assisted by groups of subjectmasters and pedagogues. The finished articles are then distributed through commercial channels. Every teacher should however be able to judge an existing courseware-package and to carry out simple adjustments (e.g. terminology). After all, courseware serves the individual, and should therefore be adaptable to the local needs of each school and even to those of each pupil (this is rather utopian). You will discover the possiblities and (current) limitations of the systems, only after having sufficiently practised and experimented with the computer.

e. the man-machine realtionship

Here the computer is situated in its social context.Besides the consequences of introducting the computer into society we will in particular dwell on the consequences for individuals, groups and education.It is our intention to bring the (future) teachers into contact with situations in which the computer has, had or will have an influence on social and educational structures.The (future)teachers will have to be urged to reflect on the causes and consequences of these situations and to take up a position regarding the influences of the computer on the social, economic, political and educational level. This part can be divided into two sections:

- possibilities and impossibilities of the application of the computers;
- effects of application.

Things that can be discussed here are e.g.

- the application of computers can lead to an essentially different way of reaching dicisions computers requires the institution of new functions and professions
- automised word-processing demands logical and rational ways of thinking of the parties concerned;
- changes in the organisation of labour lead to relative shifts between the various sorts of labour (schooled, unschooled,...) and thus lead to problems in training people for various tasks;

- the high costs associated with automation can result in an unequal spread of access to information.

f. information on computers and education

In view of the very rapid evolution in the computersector it is important for (future) teachers to know where they can go for further and up-to-date information. They have to be brought into contact with the leading magazines or books that deal with, and organisations that are active in, the field of computers and education. They also have to be aware of the existence of online research-services, networks, telesoftware and the most important dealers in hard- and software.
If we leave points d and f out of consideration, we have a package that should in fact belong to the basic training of every citizen. The topics mentioned concern a minimal package that every teacher should master.

2.2. A supplementary formation of teachers of informatics

Teachers who teach a specific computer-subject (this mainly concerns higher education) of course need more than the basic training for computer and education. In practice, teachers of informatics should:
- be able to write structured programmes and evaluate existing programmes on their efficiency and appropriateness;
- possess a basic knowledge of computerarchitecture;
- be aware of the specific educational expedients for their subject.

For the elaboration of an educational programme for these teachers we refer to De Corte (1984,2).
In working out an educational programme for these teachers a lot of use is made of the 'structural plan refresher course secondary education' (PAO, 1983).

a. continuation of problem-solving thinking and programming

The intention of this part is to develop an attitude and cognitive skills belonging to it, in order to:
- be able to discern which problems stated can be handled by way of an algorithmic approach;
- develop algorithmic solutions for problems appropriate for this purpose in a systematic manner;
- translate an algorithmic solution by way of one or more available higher programming languages as a programme.

In this tripartite the three fases in which problem solutions come about are clearly reflected:
- the analysis of the problem;
- the design of the algorithm;
- the programming.

The site and complexity of the problems submitted have to be such that a first impulse for a solution strategy is reasonably simple to find, or has even been given. After this a step-by-step refinement can take place.

b. principles of the build-up of software and apparatus

Our intention is to gain insight into an elementary knowledge of the different levels that determine the architecture of computer-systems.Key concepts are:
- process
- algorithm as the description of the process
- processor as executor of the process
- 'interface' as the description of input- and output objects of the process
- protocol as the description of the way in which objects are exchanged between two processes.

The intention here is that you get some notion of the fact that an automatised system can amongst other things be thought of by dividing it into layers (and that is possible in several ways), in which each layer is characterised by a few processes communicating with their processors via objects. Important layers here are:
- semi-conductor components
- circuits
- micro-architecture
- conventional machine-level
- level of assembling-language
- master system for apparatus
- translators and interpretes for higher languages
- master systems for databanks
- application software
- network-architecture.

Not all levels need to be dealt with exhaustively. Thus the three lowest levels (semi-conductor components, circuits and micro-architecture) have to be treated only briefly. The emphasis should be on the other layers. With regard to the subject-matter-parts the following aspects should be dealt with in any case:

- Conventional machine-level and level of assemblylanguage:
- rough division of the collection of instruction defined by the micro-architecture;
- connection between instruction format and addressing range;
- overall contents of the concept assembly and 'linking' Master systems for apparatus:
- storage of the collection of external memories;
- informationtransfer between internal and external memory;
- 'interface' to final user via command language;
- Translators and interpreters for higher programming languages:
  - overall contents of the concepts for translation and interpreting;
  - stock-taking of the most common means of language on the basis of algorithms, which have each been realised in a few numbers of higher programminglanguages.

Master systems for databanks and softwareapplication are treated in point c. resp.f.The network-architecture need only be treated briefly.

c. Collecting organisation and databanks

The aim of this part is to develop correct models of thought built on concepts as invariant as possible. In this way usage based on insight becomes possible, despite the variety in and the change of informationssystems. The necessary conditions for developing such good models of thought are:

- Enlarging the insight into the structure and possiblities of the important sublayers of the databank mastersystem. A difference has to be made between the internal layer and the conceptual one. The internal layer describes the organisation of the collections on which the databank is built up. Our concern here is discussing the search-processes and types of collection-organisation. The conceptual layer (and the external layer derived from it) roughly describes the object-types and their mutual relations which form the datamodel of the databank. Datamodels, data-manipulating languages and (relational) questionlanguage (e.g. SQL) are treated here.
- Getting acquainted with the structure of (a part of) at least one existing databanksystem, especially directed to filling in the internal and the conceptual layer.
- Design of a small databanksystem, also directed to filling in the internal and conceptual layer.

d. computers and society

Within this subdivision the following subjects have to be treated:

- information and society (information processing, information technology, 'the third wave', ...);
- automation of the information processing and process direction in various sectors;
- influence of the information technology on daily life, work and study, organisations, democratic and social structures, international relations,...
- the sector of the information technology.

e. didactics of the information education

Our concern here is the specific features of the education in informatics, i.e. in what respect does offering informatics-education distinguish itself from offering education in general? The didactics of information have to aim at an execution of the central objectives of the informatics-education. In this didacticians aim themselves at stimulating, starting and keeping the processes going which have level-raising learning as a result. So the intention of this part is to offer insight and skills , in addition to the development of an unjustified attitude towards the aim in view.

f. computers, application programmes and education

Our purpose here is to make the teacher familiar with the use of the computer in education and to get him acquainted with the different kinds of application programmes, which can or cannot be used in the classroom. We have in mind applications such as:

- wordprocessing;
- informationsystems;
- simulation of physical and administrative systems;
- specific applications in education.

Not only the possiblities but also the restrictions regarding the use of application programmes in the classroom have to be discussed. Of each application we should alsd treat:

- the way in which the application is used in practice;
- the possiblities for presenting the application under discussion in an elementary form to the pupils. The information teachers will play an important part in the introduction and the management of computers in schools. As they are thoroughly educated in this field, their advice concerning the acquisition of new, and the

expansion and the maintenance of extant computersystems and software, is indispensable. Being in this position, they can play an important role in the development of new as well as the adaptation of extant courseware.

g. present and future developments

The evolution in the field of computer architecture, database systems, computer communications... and the tendencies, as far as education is concerned, will have to be watched closely.

2.3. A supplementary training for teachers who do not teach informatics.

The educational use of the computer in the various disciplines demands special attention of the teachers during their training. The specific possiblities and restrictions of the computers and the extant courseware for their specific discipline (secondary education) or age-group (primary education) have to be discussed. In other words all teachers (secondary education) will receive an explanation as to how they can use the computer for their subject in their specific discipline in an efficient and effective way . The same holds for primary education in general with age-groups. In more specific terms this implies that teachers should:

- be able to apply the computer for their specific teaching-task;
- prove to be able to work with the particular aids that have been designed for their teaching-task. We have in mind, for example, the use of educational games and the programmation in LOGO for the primary education, the real-time computeruse for laboratory-experiments in the teaching of physica, the use of word-processors for writing essays in language-teaching,...

3. The teaching of informatics in Flanders

For clarity' s sake we distinguish between the use of the computer as an object of study and as a didactic aid. School-administrative applications will not be discussed.

In so far as the computer is used as a didactic aid, we mean teaching and learning with the help of the computer and by means of the computer. We use the terms Computer Steered Learning and Computer Assisted Learning, often referred to with the abbreviation CAL. The use of the computer as a didactic aid is still in its infancy. At the moment it occurs only sporadically and without co-ordination. When we speak of the computer as an object of study, we have in mind the teaching and learning about the computer. In general we notice that the computer is treated first as an object of study in one subject and is only integrated afterwards in the other subjects.

3.1. The computer as an object of study

The computer as an object of study in the subject "initiation in informatics", in a specific information-training and in the general information-subjects.

a) initiation in informatics

A general educative subject "initiation in informatics" (for 15-16-year-olds) will be obligatory from the academic year 1985-1986 onwards in all divisions of secondary education. The purpose is a large-scale "computer-alphabetisation" of the pupils in secondary education similar to a number of foreign projects (The Netherlands: lingerinformatica; Great-Britain: computer-awareness; The United States: computer literary). In the Board of Education a special committee "Education and Informatics" was established for this purpose. In a number of pilot-project schools a provisional curriculum is being tested at the moment. During the academic year inservice courses are organised for teachers who will be teaching the subject next year(*) The subject "initiation on informatics" should consist of three components: A descriptive component: what is a computer, what does it do and what can it do? Problemanalysis: the intention is to teach the pupils to programme (in the broadest sense of the word)The main stress has to be put on the 'formulation of questions, on algorythmical thinking and on teaching how a solution-strategy can be developed. Influence of the computer on society: the pupils not only have to see the value and

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(*) At the University of Antwerp (UIA) a symposium about this new subject was organised in the autumn of 1984.

the importance of the computer for society but also have to become aware of the consequences of its introduction. A crucial problem here is that it is not yet certain which teachers will be teaching the subject. As the number of periods during which the subject will be taught will be limited (1 hour a week for two years or 2 hours a week for 1 year) there is a possibility that it will be assigned to an arbitrary teacher to fill up his time-table. If the subject is assigned to a teacher of informatics or mathematics or to a science teacher, as will often be the case, he will have to avoid looking at he subject from one angle (thereby neglecting the social aspects and the problem-solution thinking). The problem however can be avoided to a large extent by developing a curriculum in which aims and content have been worked out in detail. We believe that a clear instruction in the initial stage is indispensable.
Another problem is the absence of all theory of learning for this specific subject. Nevertheless, a large-scale in-service training for teachers has already begun. In the autumn of 1984, 25 secondary school teachers got an in-service training of three months at 4 Flemish universities (KUL, RUG, VUB and UIA). These teachers will have to bring their colleagues up to date in the spring of 1985 and they will have to compose a series of lessons, thus giving a more concrete form to the course "Initiations in informatics".

b) specific informatics training

Specific informatics trainings take place at various levels:at universities (engineer, licentiate,...) at technological universities (informatician, system-analyser, programmer) and in a restricted way in the secondary schools (since 1969-70 there have been trainings for programmers). This education has to be taken care of by informaticians with a supplementary pedagogic-didactic training.

c) general informatics subjects.

The application of informatics in the various disciplines have been common for quite some time at university level (faculties of science and applied economic sciences) and in technological universities. In secondary education we have the special option "informatics", "trade-bookkeeping" and secretarial courses" (in the latter two cases the wordprocessor is introduced as an application); the complementary options "informatics" and "informatics and programming"; the 7th specialization year "informatics" and so on... The main emphasis should be on the development of lasting techniques and insights and not merely on the use of a given type of machine, which usually becomes olsolete in no time. In any case there is no doubt that it is desirable for these subjects to be taught by the subject masters (f.i. the teacher of economy for applications in the field of economics) who know and have experience with applications in their speciality. It is essential that present and future computer applications are treated in the various trainings, for the demand for specialists who are familiar with informatics increases more than the demand for pure informaticians does.

3.2. The computer as an aid.

Most computer applications are not to be found in the field of education but in industry, administration, the medical science, the army, the information industry, research... Research and development in the computer industry, not only hardware but also software, has always concentrated on other fields than education. The last few years, however, there has been a change. Teachers themselves try to implement computer applications that were originally not intended for education. Thus, for example, the principles of computer aided design are used in education to get the pupils to learn the basic principles of technical drawing.Also, in special schools the computer has proven to be a useful working instrument. Other applications are word-processing, programmes for numerical analysis, information treatment, the drawing of high resolution graphics, animation, synthesizer,... Another striking example is the real-time computeruse when teaching the natural sciences. In this case the measuring-results of an experiment are the direct imput of the computer which acts as assimilater. The computer as an aid occurs in all subjects previously referred to, but not often enough (and mostly not) in the non-informatics subjects. The measuring use of the computer in non-informatics subjects occurs now and then. There have been, as has been mentioned, experiments in subjects such as mathematics, physics, and to a minor extent in language-teaching and primary education. The reasons for the limited use of the computer are obvious: these teachers do not know very well what they can do with a computer in their lessons, they are not aware of the possiblities of a computer system in education. In-service training in this field is therefore necessary.

4. The computer and the teacher training in Flanders.

We have described the required computerknowledge for (future) teachers, we have outlined the situation abroad as far as the training is concerned and we have traced the present state of affairs in Flanders in the field of the teaching of informatics. Now we will analyse the consequences for teacher training of introducing the computer into education. The problems here are of a structural kind. On the one hand the teacher training itself hasn't been sufficiently orientated towards the new field "computers and education", and on the other hand the possibilities for in-service training are not sufficient.

4.1. In general

In the teacher training for primary and secondary education the computer deserves a place of full value by the side of the classic audio-visual equipment. To be more specific this means that all teachers should have studied the computer as an object of study and know how to use the computer as a didactic aid in their lessons. The question whether all this makes it necessary to create a new subject or that the subject-matter has to be integrated in the extant subjects of the teacher training will not be discussed. If we suppose that each pupil in secondary school receives an introduction in informatics, the basic trainig "computer and education" during the teacher training can be shortened drastically. In the training of teachers for kindergarten the basic training "computer and education" is so far sufficient. If the computer should become more important in nursery schools a supplementary training might also be necessary here. A problem for the teacher training is the question as to who will give those future teachers their basic, and if necessary their supplementary training, "computer and education". And how is the in-service training for these people to be organised?

4.2. The training of informatics-teachers

We will restrict ourselves to teachers of "higher secondary education", as informatics as a subject only exists in higher secondary education at this moment. It is obvious that the formation on the level of the subject-specific content has to take place entirely during the informatics-training and that the teacher training only takes care of the didactic aspect. This implies that these people will have to go through the basic training " computer and education"(though they will be exempt from many subdivisions) and the supplementary training for informatics-teachers. As there are quite a few problems with the training of informatics-teachers we will pay some extra attention to this group. For the time being, BASIC remains the programming-language, for practical reasons. Some teachers to be do not get a BASIC-course during their training. This is of course not disastrous. Everybody who knows Pascal or Fortran can learn BASIC in no time. Nevertheless, this remains a temporary obstacle for the teacher training. At the moment there seems to be no way to remove this obstacle as the evolution in the field of programming-languages is rather fast. ELAN for example will be the leading programming-language in secondary education in a short while (like the situation in The Netherlands and Germany). For each subject a specific theory of education has been developed as time went by. As informatics has been introduced into education in less than no time no specific theory of education has been developed yet.At this moment informatics-teachers use the general theory of education and the specific theory of education of the subject for which they graduated. As a result some essential issues have been overlooked. Apart from this a great number of typical problems arise such as the installation of a computer class, the maintenance of the microcomputerinfrastructure that is available, the organisation of team-work, (very important when you are dealing with larger tasks and a restricted number of computers), etc. It is essential that the main objectives for informatics are formulated clearly. For, since the introduction of the subject "informatics and programming", we notice that many teachers situate the main objective of this course in the " coding in BASIC" of a number of applications. Consciously we use the word "coding" because their puplis indeed do not learn anything else. During the training of informatics-teachers it must be made quite clear that informatics is more than merely programming in one or another computerlanguage.The build-up and operation of a computersystem and the social consequences of "computerisation" ought to be discussed in any informatics-training. Programming is of course an important aspect of informatics but it should be viewed in its entire context. The main purpose of programming is the solving of a problem by means of the computer (differential comparison, wage-calculation). The most efficient solution-strategy must result from a top-down analysis of the problem. The entirely worked out and structured solution (e.g. in flow-chart or pseudo-code) is afterwards translated into a programming language and thoroughly tested by a computer. So the "coding" or translating is only one, non-creative part of programming. The choice of the programming-language for secondary education has been a point of discussion for quite some time. As the first programming-language you learn influences your programming-style strongly it must be chosen with complete care. Structured programming is necessary. What is meant by this is the systematic application of a "step by step refinement". Formally anything that can be programmed can be expressed in no matter which programming-language. It will however be easier in a language that corresponds closely to human habits or thought. A programming-language for secundary education therefore must support the systematic formulation of algorythms through means of abstraction of algorythms and proper information-and controlestructures. In addition this language must be defined exactly and consistently.Usually BASIC (interpreter, available everywhere, structured) and Pascal (compiler, structured) are weighed one against the other. As has been mentioned above BASIC is still used at this moment though ELAN is considered to be the most appropiate language for a first acquaintance with programming. The role of the programming-language can be pushed into the background if you go for analysis which is a (structured) solution written in a pseudo-code.

5. Information technology and the in-service training

As the training only reaches future teachers a relevant in-service training must be organised for teachers who are already working. So far initiatives for in-service training have been taken by universities, schools for higher education and private institutions (banks, teacher-associations, publishers) though without much co-ordination. Even if there is a lack of co-ordination in the efforts, it appears that there are relatively more in-service trainings for informatics-teachers than for the larger group of other teachers. Thus there is the threat of a gap in the school between those teachers who have a basic knowledge of informatics and those who havenot. Therefore it is necessary to give a thorough in-service training on computer and education for all teachers. We consider the basic education "computer and education" to be absolutely indispensable. For those teachers who are interested, supplementary courses must be organised afterwards. The content of the in-service training has already been discussed, but how the in-service training is to be considered is not yet clear. We will discuss these forms of in-service training which are not inter-related but which may complement each other.

5.1. In-service training through institutions acknowledged by the authorities

We have in mind in-service trainings organised by universities, schools for higher education and schools for refresher courses. In the Netherlands it is the general opinion that in-service training should be entrusted to specialised institutions. The foundation"teacher" for instance brings a few hundred teachers up to date through the course "Micron" each year. Those institutions or foundations are subsidized for a number of years and they subject themselves to a contract with the authorities in which their obligations are clearly defined. Suppose you want to organize something similar in Flanders, this would imply that whether extant institutions, or a that is being formed, get the contractual obligation to organise in-service training courses. The in-service training has to be geographically spread over the country and has to take place where sufficient microcomputers are available. We have in mind universities and schools for higher education. The idea to equip a number of additional normal and technical schools is definitely worth to be considered (Mertens, 1983). Such in-service training centers would beside the in-service training: - give the opportunity to all teachers to develop educative programmes themselves or to test available programmes;

- keep an eye on the evolution of the computermarket, in particular on the applications which are relevant for education and put this information at the disposal of teachers;
- investigate the educative relevance of courseware (produced for private or commercial purposes), make a short report of this and put the courseware as well as the report at the disposal of teachers.

5.2. In-service training through the media.

We have in mind the BBC series of lessons "computer and computing", the Dutch "Teleac"-programme and the initation-course in informatics recently produced by the BRT in co-operation with the RVA. The advantage of this approach is that with relatively little expenses many teachers can be reached at the same time. We're only dealing here with the aspect of knowledge,thought. Skill has to be taught elsewhere lest the expensive BBC-solution is chosen and microcomputers are offered for sale. Such broadcasts can be combined with placing a solid text-book at the disposal of the course-members and drawing up a number of weekly tasks.For this task and for the correction of the tasks the Written Education Service might be called in. It is necessary though that the teachers get the opportunity to experiment with the computer themselves. This ought to be built-in in the programme in one way or another. Teachers who are course-members and regularly hand in the tasks can be validaded by delivering a certificate which gives certain priorities in the adjudication of tasks.Or like in Great-Britain a microcomputer can be delivered at a low price to a school with teachers that have followed the in-service training.

5.3.In-service training on a voluntary basis

The lack of in-service training in many countries has been met by all kinds of private voluntary initiatives. In the United States for instance there would hardly have been some task of any form of computereducation if this kind of improvized and non-organized education didn't exist. The initiative for this spontaneous in-service trainings is mostly taken by teachers who started working with the computer on their own and wanted to share their knowledge and experience with colleagues (think about the society "School and computer").

Conclusion

We can state that in the present teacher-training hardly any attention is given to the phenomenon computer. Because of the rapid evolution in this field this will have to change quickly. If not, education will get out of date. We'd like to consider the computer as one of the audio-visual media and we'd like to inform the future teachers of its possibilities and limitations as a didactic aid. The subject-specific use of the computer is material for subject-didacticians. For a maximum progress of the learning process of future teachers informatics and for a good schooling of the teachers who are responsable for this training, a subject-specific theory of learning for the subject informatics is necessary. Problem-solving thinking has to have the main emphasis. In-service training on a large scale should make it possible to give a basic training "computer and education" to present teachers.

WITH THE COMPUTER AS ALIBI?

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Introduction

1. Secondary education
2. New didactic goals
3. New didactic methods
4. A more efficient didactic organisation
5. Key points for management

Introduction

Although an organisation such as 'Flanders Technology' is obviously primarily geared to leading technological developments and their possible economic and social relevance, it is also a very important event for schools and education. This importance is not only to be considered from the viewpoint that students and pupils were given the opportunity (one which was , by the way, readily taken up) of visiting it. The signal emitted from such an event, and subsequently received by education, is much more fundamental than that; if education is able to decode the signal correctly it can distill several crucial meanings from it:

- what is in fact the degree of actuality, of quality, etc. of the objectives aimed at in school?
- what possibilities can technology offer us to optimalise the leaving and training process (by making itmove efficient, by making it rum more effective, etc.)?
- is the traditional organisation of this process (the organisation into subjects) still able to answer enterrial demands made on it?

It would doubtlessly be commendable to tackle this decoding more systematically from within the management of education; we will return to this furtheron.

Furthermore, it is very important that this is not done shortsighedly, solely with a view to the demands of a specialised training at university or even at a higher level, and partly also in the last stages of secondary education, if only to prepare the pupils for the choice of a specialisation lateron. What's more, history has repeatedly shown that, if the (technological) developments are not to stagnate, the experts have to get a sufficient hearing in the broaden layers of society and the working population. This can only be so if, through their basic training, enough participants in society are able to understand the importance of such developments, and assign them a justified place within a broaden social content. (1)

With these general remarks we have come a bit closer to our specific topic. We have already given a first principal answer to the question of the integration of the new information technology into secondary education. What goes for leadinfg technological developments obviously goes for one of their sub-divisions. Informatics, with the computer as its figure-head, has already had such an impact on our society that general (threshold informatics) and specific (typical consumer and specialised informatics) training ought to occupy in this respect an important place in secondary education. We would like to elaborate on this general thesis in what follows.

Starting by briefly situating secondary education in general, we would like to then enamine the changes informatics should cause in the objectives, and which new objectives would be required, at this level of education.

The effects of introducing informatics in secondary education are however more far-reaching than only those concerning the changing of objectives.

The computer's presence in the classroom, the possibilities it has for dealing efficiently with large amounts of information,; its ever-increasing user-friendliness, have all given a new lease of life to old didactic dreams of efficient and effective education. Is this justified or not? Are we indeed evolving towards a 'hal-of-machines'-type of classroom, or will everything stay just as it is? Obviously, this is also a problem which deserves our full attention.

It is clear that both the learning 'about' as well as the learning'with and through' the computer poses us all difficult and important questions, in particular to those who have the management of schools.

We would like to round off these remarks by trying to formulate the beginning of an answer to a few of these questions.

1. Secondary education

In many ways, secondary education is, like everywhere else in the world, the worst complex level of education in our country. Because in its entivety it tries to get its pupils to realise so many different objectives, its form has become in practice a complicated network of paths and cross-roads. Primarily, secondary education tries to give all its pupils a broad, socially-directed basic training; in primary education the focus was mainly on the exploration of the immediate surroundings and the teaching of elementary skills; now all this knowledge, all these skills and attitudes, have to be realised in higher education, so that adult social participation in a broader perspective becomes possible. Furthermore, at this level of schooling, the first steps which will lead some pupils very temporarily, and others much more definetely, towards their specific social role (especially to be seen in the preparation for a profession), are taken here.

To enable secondary education to fulfil its dual role in function

of the pupils'social needs and personal development, a very large choice of studying possibilities was developed, and organised in the form of a treediagram (type I) or in that of a cluster of streams running parallel to oneanother (type II).
Our satisfaction with the temporary end-result of all these developments is still an unanswered question; the disputes on the merits and disadvantages of both types which are still going on show that for many, that question cannot be answered positively yet. What remains a problem to this day in particular, is the old tendency of our schoolmanagement to think of education primarily interms of structures and administrative arrangements, and only in second instance in terms of objectives, and the contents and level of the training given. Many well-meant renewed objectives drafted by the management as well as by idealistic individual directors and teachers have come to grief on schooling structures determined by the law, on norms for puupils, and on rules concerning sufficient proof of ability. Typical of this is for instance the way in which education plans are still drafted in our own country, eventhough here too more 'democratic' structures, in the form of a curriculum for secondary education, have been developed in the wake of the evolution of type I to type II. A curriculum for secondary education is still very much an intersubjective 'insiders'-attempt. No mention whatsoever is made of systematic social inquiry, eventhough a social forum obviously has to decide on the relevance of educational objectives.Furthermore, too many makers of schoolcurricula seem to think in terms of a 'top-down'strategy;what has been organised in a 'logical' structure (for example in a scientific discipline) is then, after many difficulties and an evolution lasting years, transposed to the school in the same structure, but in a slightly watereddown form. There is hardly even a mention of a 'psychological' structure which, starting from the pupil, then developes into a didactically justifiable sequence towards the presumed didactic goals aimed for in the curricula. In this respect, there is hardly any need to reproach the curricula-makers themselves; in my experience they are well-meaning inspectors and teachers who have to draft something fairly quickly and in thankless circumstances. What is missing is a whole cluster of related expectations of society itself, and of the world of trade and industry in all its areas, etc, which can be used as a basis on which to draft these objectives so that they are relevant enough. What they miss is the necessary didactic supervision needed to be able to convert their subject experience (their knowledge of the subject) into a real curriculum based on

empirical findings. Consequently, at this moment the objectives for secondary education can only be talked about in general and therefore vague terms. In general, the development of these general final objectives into more operational didactic goals is so conspicuously lacking, that the checking of secondary education's output is made nearly impossible bhecause of it. For instance, in connection with the theme of this meeting, it is almost certain that several crucial didactic goals could already be aimed for in several subjects. Information is dealt with in every subject, several subjects offer the chance of acquiving effective attitudes towards automation by giving algorythmical solutions to problems, and so on. We are all doubtlessly agreed that secondary education ought to prepare pupils for a quickly developing information society; intuïtively we may even feel that something ar other is already happening in that direction; however, we miss the necessary instruments to garantee this definitely. Many experts, using legitimate didactic arguments, argue that the integration of informatics into secondary education is best not done by devising new subject for it. In my view, the management, confronted with the now existing situation which cannot obviously be changed at a moment's notice, has little other choice. We can only heartily recommend that the old mistakes do not occur again, and express the hope that the installation of new subjects will in this instance be supported by the development of a responsible curriculumsight from the start.

This is the first way in which the computer could serve 'as an alibi' to optimalise secondary education.

2. New didactic goals

It needs no emphasis here that a quick evolution of the practical importance of data-processing, and of the apparatus by which this can be done efficiently, can be noticed in our society. EVery participant of our society can experience this daily. It is also obvious that this importance will increase sharply in the future. From a social and a personal point of view, school can therefore be expected to offer at least three levels of chances for preparation: 1) by letting everyone acquire, as part of his general training, a sufficient degree of threshold-informatics, by which is meant the knowledge, skills and attitudes necessary for taking an active part in the information society as an average citizen (compare this for example with the Dutch use of the term citizen-informatics), so that he also can help guard the orientation of its values, etc. More concretely this threshold-informatics consists of basic contents from two areas, which we could call informatics and computer-knowledge. In this respect, informatics consists of terms, structures and methods such as 'data, messages, meaning', with the collecting, integrating and presenting of the problems, algorythms, etc. and with such attitudes as a sense of correctness, of criticisme, tidyness, etc. Computer-knowledge is concerned with experiencing and becoming familiar with the computer as an instrument, its functionality, its usefulness, its implied advantages and disadvantages for society and the individual, etc. Both areas will have, after careful selection,to be converted into objectives in a didactically justifiable curriculum.

2) by letting anyone who is preparing himself for one or another profession acquire a sufficient degree of user-informatics. Naturally, the concern is here also for knowledge, skills and attitudes, not at an introductory level however, but directly related to the chosen profession. Thinking in terms of the four existing educational systems, the following examples can be given:

- applications such as word-processing, statistical analysis, and managementusage must certainly be used in the ASO, in the economical educational streams;
- in the TSO and the BSO, and depending on the type of studies, the pupils must be taught how to use the computer as a regulation-and supervision system, as a measuring instrument, as an administrative aid, etc;
- CAD/CAM applications will have to be assigned a place in amongst others, the KSO;

3) by affecting, to those who want it, the chance of training specifically in the area of those professions, which can be situated in the more specialised atmosphere of informaticsand computer-knowledge itself (i.e. production, simple programming and working with information-assimilating apparatus). Didactic goals aimed at higher levels of knowledge, skills and attitudes will also have to be developed here, based on the introduction of the threshold-informatics.

An interesting synthesis of the two levels of information technology in secondary education mentioned last, can be found in a recent Dutch advice sent to the government.(2) Here, the two levels are divided into three zones related to hardware (A=apparatus), software (P=programming) and to its usage (T=application). When the terms are adapted to our language use, we get the following:

T

users

specialised
appliers

(makers of application)

makers programmers

A P Based

on the distances between the three corners of the triangle the relative contribution of the three components in the training can be (roughly) situated as follows:

- the users will have to achieve many didactic goals related to application, and which have little to do with the apparatus and programming; - the makers will form on the apparatus, less on the programming and least of all on pragmatic applications, practical use, etc..

The eventual selection of didactic contents with which to fill up this triangle will have to be based (it must be repeated once more) on a systematic questioning of relevant groups inside and outside the schools. Now these are then to be converted into didactic goals; how they are to be developed into curricula (sequence, methodical recommendations, assessment, etc.) must be done in a didactically justifiable way, and preferably with the prospect of empirical supervision and guidance. Secondary education can become, by using the computer as an alibi for adequat curricula, a better reflection of the society for which it prepares its pupils.

3. New didactic methods

The quick evolution in quantity and qaulity of the impact of the computer on our society has not only meant thzat the pupils must learn 'about the computer' at school. Computers are machines which deal quickly and efficiently with information, according to a programme which has been worked out beforehand. In principal therefore, computers can be used wherever there is 'assimilation of information'; naturally enough, this is also the case where schools are concerned. It is therefore hardly surprising that computer didacticians quickly discovered the possibilities for improving the learning-and trainingprocesses (*); experiments were already being carried out from 1960 onwards in the USA, while here too initiatives in that direction have been tried out in several schools for the past few years.

As is the case with each initial renewal of didactic methods, we are still in an exploration phase in which many usage-possibilities (whether scientific or not) are hbeing tried out. Hopefully, this will eventually lead to a situation whereby the presence of a computer in the classroom will be regarded as normal as is now the case for the pen and paper, or blackboard and chalk, without the classroom however being degraded to a kind of amusementpark. As has been mentioned before in connection with learning 'about the computer', the didactic goals aimed for in this instance are of primary importance; engaging a computer or not is a decision of the third order, as is the case for any other teaching aid in the didactic process. First the didactic goals have tot be decided on, then a decision can follow, depending on their nature and level, on the most desirable form and circumstances which can help realise them. A possible more or less integral usage of the computer is to be situated only within the decision on the method. Severable tenable divisions can be found in the literature concerning the different applicationmodalities of the computer.(3)

Following the line of thought above, we prefer a division here that joins on to the behaviour levels that De Block (4) differentiates in relation to the didactic goals.

a) knowing

Leaving aside the crucial ready knowledge which will remain necessary even in thez most advanced technological society, it is obvious that in our time, there is little sense in learning as much as possible (by heart), although this doesn't seem so obvious if you examine tests and exams in current schooling. Didactic goals which are solely aimed at merely 'knowing' should be selected very strictly; a large portion of the remainder could then be moved to permanently accessible sources of information.

(*) We will not go into the many investing possibilities for also using information technology for efficient administrative and documentary work at school.

This would then become a kind of 'mandated' learning. The computer can serve excellently hezre by 'knowing' in a two-fold way: for the meaningful (in a content) practising of the crucial forms ready knowledge ("drill and practice"), and also as a well-organised source of information, whereby 'knowing it yourself' is replaced by 'adequately knowing where to find it'.

b) insight
'Insight' means that a pupil assimilates external knowledge in a personal way, untill it has become a part of him. In tradtional schooling this level of behaviour is principally aimed for in two ways: by giving the pupil explanations, definitions and demonstrations on the one hand, and on the other by letting the pupil achieve the required level of knowledge through self-exploration. The didactic superiority of the second method has been accepted by didactics for a long time now, which does not mean that reasons for using the first method in well-defined circumstances (e.g. for saving time) are totally excluded. Both methods have no problems with the engagement of the computer into education. Whether there should indeed be a use made of this instrument in both methods vezry much depends on the didactic values it happens to offer. In the case of 'explaining' and 'showing', this value, depending on the didactic goals, can be seen in the excellent possibilities the computer offers as a 'medium': by dynamically visualising the data on the computer-screen, by letting other media (e.g. the videodisc) be guided by it, etc. And where the pupils have to search for certain knowledge themselves, the most possibilities are to be found by treating the micro-computer as a didactic machine ("tutorial CAL") (5).
At the moment, the micro-computer, used as a didactic machine, is already capable of affecting complexe (branched) programmed courses, so that the pupil gets a fairly individual course of schooling; furthermore, before long spectacular progress can be expected in this area, so that for instance the machines 'learn' from their users how they can serve future users better.
In all these cases - and naturally this also goes for all the other behaviour levels as well - the motivating effect for the pupil of using a computer may certainly not be underestimated.

c) application
'Application' means learning to deal with knowledge in such a way that you are able to solve 'new' problems with it. It need not be commented on further that this problem-sovling is a crucial moment when turning 'book-learrning' into 'operational'

social knowledge. On this level the computer can be used in a way which is closely related to its use outside school. For instance, the teachers have the opportunity here of offering the pupils well-chosen problems via the computer, whereby for example the pupils have to ask the computer the relevant questions pupils needed to find a solution to the problem.
A well-known example in this respect is learning how to make medical diagnoses; the memory-bank of the computer has all the data on a certain illness (tempertature, bloodpressure, external symptoms, etc.) which the student can then recall; obviously, it is not difficult to think up similar applications for secondary education. ("conversational CAL")(5)
Naturally, you do not always have to think of 'serious' pragmatic applications; the many possibilities the computer has are only fully done any justice when it is also used 'playfully' on this level ("gaming"). The training value of the (simulation) game (e.g.commercial games), in which you can explore the limits of the games'rules and even try out the 'impossible' (what would happen if...?), was discovered quite a while ago.

d) integration

If the knowledge and skills learnt at school are to be of any value now, and later, outside school, then the behaviour level 'integration' will have to be reached. If a pupil reaches this level, this means that he has made knowledge and skills 'his' property, and therefore spontaineously uses them when the need arises. On this level, the usage of the computer is however situated in the realm we already described as 'hope': the spontaneous and self-evident engagement of the computer as an instrument like another, for instance as happens now with pencil and paper, ruler, dictionary, and gradually even the pocket-calculator. At this level the computer is divorced of his character as a typical exercice-and didactic machine, as a thing which poses 'bookish' problems, as games-supervisor, etc. It has now become just another possible source of information, one of the many extentions of the skill a pupil shows when solving problems through independent action. Therefore it is also essential for it to be permanently available for the pupil, for that spontaneous usage.
Moreover, regarding the above, you must not get the impression that all these behaviourlevels should always be dealt with 'seperately' in the didactic trainingprocess. Maybe it can be important to pay a little individual attention now and then to say 'knowing', but because of the hierarchical nature of the behaviourlevels, for each 'insight' you also need 'knowing', and

the same goes for 'application', which also involves 'knowing' and 'insight' etc. The methodical preference of the teacher must therefore also be aimed at active and complete problemsolving, in which for instance seperate exercises can be inserted, should there be any gaps and shortcomings in the pupil's knowledge.
A lot can be done in an optimalising sense on the current practice in the didactic training process, if the computer is used as an alibi.

4. A more efficient didactic organisation

If then the computer is ot become a part of our schools, tohelp guide them and to increase the pupil's learning, why then should not the teacher use it meaningfully for a superior didactic management? The past fewyears the teacher has been drawned in a flood of recommendations coming from quickly evolving didactics: he must think up and formulate new didactic goals, develop teaching strategies, design tests, examine the pupils with them and stove the results, observe the pupils, etc. While understanding the problems a teacher may have in assimilating all that is new, we still feel that you cannot say that all this is not very necessary, that everything 'used to go along just as well' before without all these innovations. We cannot get rid of our impression that only school is allowed to follow artisan practicies, while trade and industry are forced to 'modernise' in order to survive.
The arrival of the computer can offer several solutions in this area as well. As an efficient databank it can organise and store didactic goals in relation to interesting subject-matter and good, efficient methods (good texts, institutions of problems which are stimulating, etc.) As a word-processor it can serve for reporting to pupils, parents and colleagues. As a solver of problems it can ... The possibilities are legio. 'Computer-managed' education offers a whole series of challenges which have not yet all beenexplored fully and exhaustively.
Using the computer as an alibi the teacher can change his job from adequat craftmanship to efficient management.

5. Key points for management

We have only been able to give a rough sketch in the above of the many possibilities which the quickly developing informatics and computer-knowledge offer secondary education. How these possibilities will develop in the long run cannot be predicted yet; anyone who had dared to think, just inder ten years ago, of all the current possibilities, was in danger of being accused of a tendency towards 'science-fiction'. It is exactly this unpredictability which necessitates a management which must forcibly stimulate the present innovations, but which at the same time must be open and flexible enough to make room for new possibilities.

It is therefore not surprising that we, following the train of thought of the above, argue for a managemant which is mainly directed towards content. The hinge in this respect we consider to be the curriculum.If we succeed in constructing, implementing and permanently supervising and guiding relevant curricula, in building up good provisions, then the most important support of the management has been constructed.

As been said before, the didactic goals are the most important component in this case; they can and may not be just solely the school's responsibility. In this respect it is therefore a pity then that we receive complaints here and there from trade and industry about the knowledge and skills of the school-leavers they recruit, without our having a concrete coordinationpoint in which all their expectations have been collected and stored, and put at the disposal of the curriculummakers. We are not arguing here for the didactic goals to be solely determined by the world of trade and commerce; however, it is obvious an input is concerned here which must also be of the utmost importance.

Several other managementideas can be drawn up around the curriculum as a hinge. To mention but a few:

- the necessary basic training for teachers, whereby hopefully in the current reform of the pedagogical higher education and the long-awaited reform of the teacher training this problem will not be overlooked;
- the 'in-service' refresher course for teachers, at the moment for these teachers who did not have this component in their basic training, and in the future for the changes which will have to be made in the curricula, so that they will keep up with social developement.
- the determining of specifications for the apparatus, the hardware, which would be suitable for learning 'about' the computer at school, and whereby it is obvious that multiple usage, as well as learning 'with' the computer, would be included in these specifications;
- the determining of strict criteria for educational software (subject-matter and content) which have to be considered when aiming for efficient and effective didactic goals.

As far a s the alst two points are concerned, it is a pity that the world of trade and commerce have started important and commendable initiatives (also financial ones) towards the schools, but that these show hardly any mutual coordination at all. Perhaps it is time that trade and commerce is viewed with a little less suspicion by the educational world in our country.
The Minister of Education has communicated to the divers media his commendable plan of starting up a study-and documentation centre. From our point of view it is to be hoped that the construction of curricula will have close ties with this centre; this calls for an adaptaion of the present practice of the commissions for curricula and a replenishment of their work as to the didactics as wells as to the contents. Moreover, it is also to be recommended to think of decentralisation and for instance the involvement of the pedagogical centres in a network of 'two-way traffic'.

As far as the sequence of the managementstrategy is concerned, we consider the implementation of treshold-informatics a priority; the preparation and starting up of the new subject ' initiation in informatics' is the next item in line. However, it would be naïve to presume that the rest will then automatically follow; we have already had too many disappointments concerning earlier technological innovations which, notwithstanding their undoubted possibilities, are now collecting dust at the back of school-cupboards.
In this connection decentralisation must be made workable and attainable at the level of the school society.

A last key point we would like to argue as to management is that right from the start, a scientifically justifiable, permanent assessment should be installed and kept up. Once again what appears necessary is a clear-cut and at the same time flexible law-system, open to experiments, which not only regulates the rights and duties of the researchers, but also in an equal measure the impact of the research on the practice and management in schools.

Informatics and computer-knowledge are components of a social (technical and economic) renewal which has probably never before in history presented itself at the schoolgates so simultaneous. Taking care that we give it a good reception, we have at the same time an excellent alibi for refreshing and reparing, for that occasion, a lot of what lies behind those school gates.

References

1. Heene, J., De leraar hoeft niet op te stappen., EOS-magazine, 1984, (10), pp. 21-27

2. Plomp, T., Informatietechnologie in het middelbare beroepsonderwijs, Den Haag, 1984

3. Camsta, B., Leren en onderwijzen met de computer, Leiden, 1980

4. De Block, A., Taxonomie van leerdoelen, Antwerpen, 1975

5. Dirkzwager, A., Computer-ondersteunend onderwijs, Losbladig Onderwijskundig Lexicon, 1977

TECHNOLOGY IN GENERAL EDUCATION
OPTIONS, PERSPECTIVES AND INNOVATIVE PROBLEMS
A DESCRIPTION OF THE SITUATION IN THE NETHERLANDS

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1. Introduction

In this paper we want to present an overview of the position of technology in the general education of the 4 - 14 age group in the Netherlands. For this purpose we describe curriculum options, implementations perspectives and innovate problems which have played a role in the past ten years. This paper has been compiled for the 12th congress of the "Comparative Education Society Europe" (CESE) and the "Dutch Speaking Society of Comparative Education" (NGVO), which will be held in July 1985 at the University of Antwerp, Belgium.

This paper successively deals with:

- the Dutch education system and the position of Technology therein.
- a number of curriculum options for both General Technology and New Information Technology which have played a role in the implementation process of the past ten years.
- the current situation in schools after ten years of implementation policy and the various curriculum options.
- a curriculum proposal as is now under discussion, which tries to do justice to the different options within General Technology as well as to the additional discussion on the design of New Information Technology.
- finally some dilemmas which have to be faced in the Netherlands are mentioned.

In the description of the situation in the Netherlands the following key-points are of interest:

- Technology (General Technology) is only offered to 12-14 years old.
- for the 12-14 years old this is only offered at technical and vocational schools.
- the authorities have not, or hardly, pursued a systematic implementation policy for the actual introduction in schools. This has lead to schools taking the initiative and making their own choices.
- this has resulted in a great diversity of pursued aims and design within the schools.
- in the past couple of yearts the New Informatioon Technology (Computer use) has become the focus of attention. As a result of this the discussion on "General Technology" and "New Information Technology" are in danger of being pursued along different lines.

The composers of this paper are both employed at the Katholiek Pedagogisch Centrum (Catholic Pedagogic Center) in 's-Hertogenbosch, where they are charged with the support of a catholic secondary school. After competing their study in Teechnology they worked in both industry and technical education. They have also completed a study in educational Science.

2. Description of the situation in the Netherlands

In the description of the situation with regard to the applications of Technology in the education of 4-14 years old we pay attention to:
- some relevant characteristics of the education system
- the main developments between 1950 and 1985.

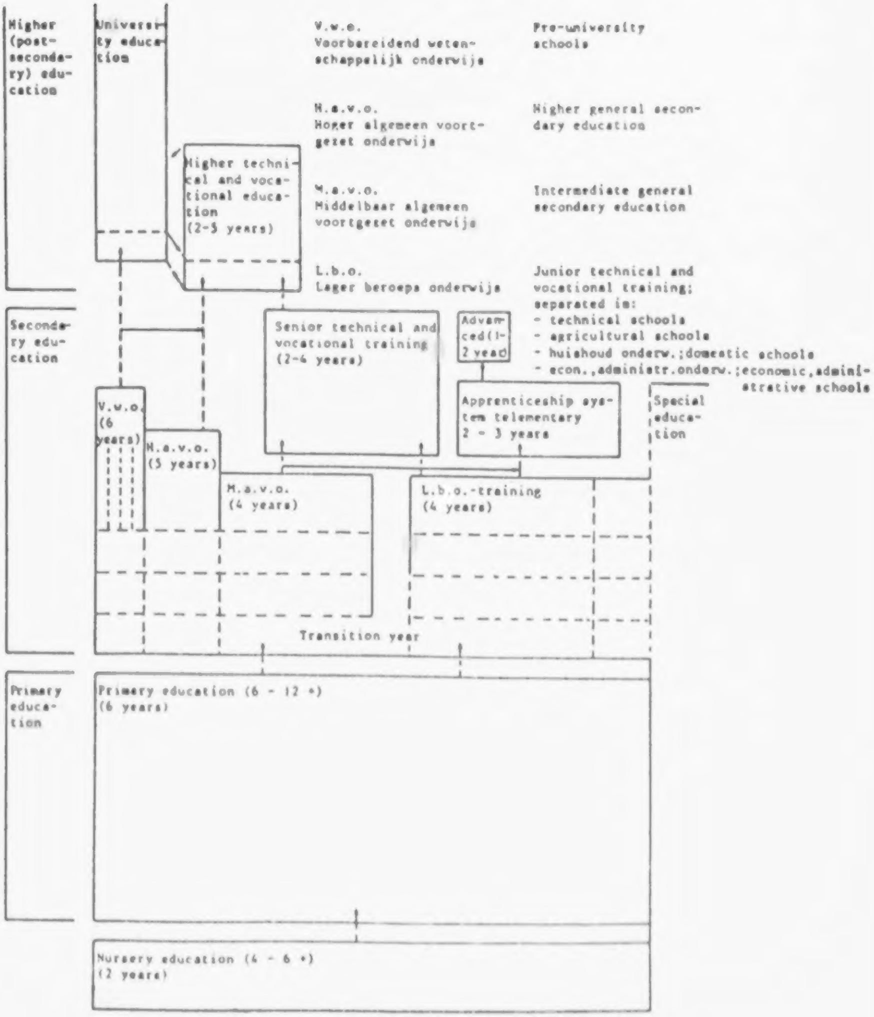
In chapter 2.2.1 we take a brief look at the curriculum options which have an influence on the design of Technology between 1968 and 1985. In chapter 2.2.2 the proposals with regard to the New Information Technology are described, in chapters 2.3.1 and 2.3.2 a sketch of the situation in the schools is presented.

2.1 Introduction

In order to get a better idea of the situation in the Netherlands with regard to Technology and New Information Technology, it is useful to take a brief look at the education system first. For this purpose the most important characteristics of the system are presented in the diagram on the next page.

In global terms the situation with respect to the design of Technology and New Information Technology in the Netherlands can be characterised as follows:

- up to two years ago hardly any explicit attention was being paid to Technology and New Information Technology in the education of students upto the age of 12 (primary education).
- until two years ago TEchnology and New Information Technology received hardly any attention in the education of the 12-18 years old in the sector MAVO, HAVO? VWO.
- until 1773 Technology was only offered as part of the technical and vocational courses (LBO).
- between 1973 and 1985 LBO-schools voluntarily started setting up courses in Technology. As a result, a number of curriculum options have been developed.


Higher (post-secondary) education
University education
Higher technical and vocational education (2-5 years)
Secondary education
Senior technical and vocational training (2-4 years)
Advanced (1-2 year)
Apprenticeship system telementary 2 - 3 years
Special education
V.w.o. (6 years)
H.a.v.o. (5 years)
M.a.v.o. (4 years)
L.b.o.-training (4 years)
Transition year
Primary education
Primary education (6 - 12 +) (6 years)
Nursery education (4 - 6 +) (2 years)

V.w.o. Voorbereidend wetenschappelijk onderwijs	Pre-university schools
H.a.v.o. Hoger algemeen voortgezet onderwijs	Higher general secondary education
M.a.v.o. Middelbaar algemeen voortgezet onderwijs	Intermediate general secondary education
L.b.o. Lager beroeps onderwijs	Junior technical and vocational training; separated in: - technical schools - agricultural schools - huishoud onderw.;domestic schools - econ.,administr.onderw.;economic,administrative schools

- from 1978 the introduction of Technology in the general education of all 12-16 year olds came up for discussion.
- since 1981 the government has adopted a policy which stimulates the introduction of Technology in secondary education.
- mid-1983 a discussion started about the introduction of New Information Technology (Computer use) in all secondary education.This created a problem of attunement with regard to the curriculum options for Technology and New Information Technology.

2.2 Curriculum options

2.2.1 Curriculum options with regard to General Technology

After 1968 the LBO started to strive toward broadening general education by means of lenghtening the duration of courses from three to four years.
For the schools the most significant changes were: the need for a second transition year, and that the second year was to be of a general technical nature.
The most far-reaching consequence of this has been the introduction of a general second year in which at least 20 periods are allocated to general subjects, including General Technology.
According to the government the aims of the new subject, General Technology, are as follows. In addition to being educatively occupied with materials (as in handy crafts) the accent needs to be placed on both problem-solving skills and the learning of various other skills. Following on from this some orientation on the fields of work and occupations can be offered. This does not involve the acquisitions and performance of skills belonging to certain occupations. The subjecty should however offer students the opportunity to develop their motor skills and their thinking capacity.
For this purpose general technical phenomena should be used to illustrate the existence of scientific and mathematical laws, and to promote their application.
Due to the fact that the government pursued a very reserved policy in the period between 1973 and 1980, the actual introduction of the subject is also determined by:

a. the limiting conditions and circumstances within the school itself (see also chapter 2.3)

b. the curriculum changes which have influenced certain groups of schools in this period.The schools themselves determined wether or not to adopt these changes.

The afore-mentioned circumstances have lead to the content of the subject General Technology being strongly determined by the actual situation within the schools. This has also lead to there not being generally accepted view on General Technology in mid-1981.

Although many aspects and sides of General Technology have already been worked out and explained, the discussion about the content goes on. Recently, since 1984, pointed questions have been raised, such as: "the question remains, what's technical about General Technology". "Isn't General Technology too much a matter of manual dexterity?", "the subject is insufficiently based on basic principles".

In order to get a better understanding of this discussion, the situation in the schools, and the perspectives of the curriculum proposal indicated in chapter 3, we take a brief look at some of the perceptions and curriculum options which have played a role in the period 1973-1980.

1. As starting point we take the afore-mentioned government explanatory note on General Technology accompanying the introduction of the general second year in lower vocational and technical education (LBO).
2. In 1974 the Landelijke Pedagogische Centra (National Pedagogic Centers) produced a paper on General Technology (24). The paper provides an analysis c.q.inventory of what schools consider to be important. The committee came to some nine key-aspects. Those which are relevant to the discussion are:
    - to acquaint students with materials and applications.
    - to afford students an insight into scientific and mathematical laws.
    - to promote problem-solving processes.
3. In the same period, Messrs. B.G.Ris (26) and E.Velema adopted the following attitude within the frameworkof developmental projects:"the object of General Technology is technology. Technology encompassess all the principles and laws which play a role in this. In particular the principles of Physics, Chemistry, Mathematics and Mechanics. Some of

which can be studied on the hand of concrete applications c.q.technical phenemena".

4. In 1977, the Landelijke Pedagogische Centra produced the "Blue-print for 'General Technology' for the first and second years of lower vocational and technical education" (27).In this the central aims of General Technology are seen as:
   a. to acquire the skills neede for the setting up and execution of handling strategies.
   b. to integrate and apply knowledge from other subject areas.
   c. to allow students to discover that mind, heart and hands are one.
   d. to instil a critical insight of what technology means to man.

   Typical of the above is that there is hardly any mention of the content of General Technology. All phenomena which can be shown as technical as such, are acceptable in the learning process. Although an arrangement in themes, closely related to the interrests of the students, is opted for, and a greater emphasis on the learning of basic skills.
5. In May 1978 a group of directors produced a report on a study into the state-of-the-art and the views held by schools with regard to General Technolgy.

   The report mentions five sectors within which lessons of General Technology should be covered, namely:
   - economics sector
   - agricultural sector
   - social sector
   - technical sector
   - welfare and care sector.

   Although the aims are fairly broad, the emphasis lies on the practical character of the subject and on vocational guidance.
6. In 1981 the Landelijke Pedagogische Centra compiled the first design of an Innovation Plan General Technology (12). The aim was to carry out planned developmental and distributive activities which would lead to schools for secondary education being given the opportunity to offer Technology in the first and second year. With regard to the content of Technology this concerns the following:
   - technology in everyday life
   - knowledge aspects from scientific disciplines
   - materials and instruments c.q.tools
   - solutions which will ease human existence.

With regard to the set-up and implementation, a core programme which includes the use of practical work and skill exercises is suggested.

7. In 1982 the Stichting voor de Leerplan Ontwikkeling (the Foundation for Curriculum Development) published a discussion paper entitled "Man and Technology" (3).
The government used this paper as a starting point for the further development of her policy. In the paper, Technology is described as "The field of activities of man, based on an accumulation of knowledge elements and capacities, through which he/she can provide the means to adapt the environment to his/her needs, in the interest of him/herself as well as in the interest of groups. The latter also infers a responsibilitu to the environment".
On the basis of some eight starting points, sixty-four subject objectives are formulated and arranged around the topics - materials, energy and information. The learning content is grouped around the themes: environment, work and occupation, leisure time and social class. These themes should be related as much as possible to the life and experience of the children.
In this paper we want to confine ourselves to the afore-mentioned seven curriculum options.
Although the various studies show a multitude of options, we can distinguish three aspects which often come to the foreground.
   a. Basic knowledge and basic skills are central. The content of technical subjects in the upper school and the fields of work, for which students can be trained in the upper school, receive particular attention.
   b. Insight into the general principles and laws which form the basis of technology.
   The acquisition of the different skills needed in problem-solving receive particular attention.
   c. The meaning of technology in everyday matters such as housing, environment, communications, industry, etc. receives particular attention. The student is brought into contact with the meaning and the consequences of technology and technical developments for society.

Recently, two dimensions have been added to the discussion, namely:

- the government has decided to start developing the subject "Care and Welfare". This should consist of elements of "Domestic Science-Hygiene-Botany and Animal

Care-Nutrition". As some aspects are related to c.q. overlap with General Technology, this requires the necessary attention.

- since 1984, schools offer lessons in Computer use. This takes place within the framework of a policy which stimulates information technology.
  This raises the question as to wether or not this subject matter should fall within the framework of the subject General Technology (see chapter 2.2.2).

2.2.2. Curriculum options with regard to New Information Technology

Since the beginning of 1980 the discussion about New Information Technology (i.c.computer applications) in education has gained momentum. In september 1982 the government published a paper entitled "Education and New Information Technology". Projects in computer studies were started in one hundred schools for 12 - 15 year olds.Within a not too rigid framework, schools could get acquainted with the introduction of Computer Studies (learning about New Information Technology).

The aim of the projects in these one hundred schools was to discover which learning objectives and implementation forms could be applicable to 12-15 year olds.

In February 1985, the Stichting voor de Leerplan Ontwikkeling developed the first version of a syllabus. In this the design of Computer Studies is briefly formulated as follows:

> "Man needs information in order to solve certain problems. This information must be obtained by means of selecting data. This data can in some cases be processess by a data processing system (a computer). Such a data processing system works according to certain principles, via certain instructions. The knowledge and interpretaion of those principles is important here, moreso because the use of data processing systems has far-reaching effects for the individual, who has to learn how to use them, and for society c.q.sectors of society. Their relevance therefore also belongs to the content."

In short this is the main content of Computer Studies. In the form of a general aim, this leads to the following formulation.

The development of knowledge and skills which will enable students to react with insight to situations in which the use of data

processing systems is possible or indeed necessary, and which will enable them to give a critical assessment of the effects the use of such systems have on society. This general aim can be reduced to specific aims, which correspond to the topics covered in Computer Studies. Again, this description is only meant to give the reader an impression of the dimensions of the subject area and should be regarded as temporary and incomplete.
We use a classification consisting of four categories:

a. Information processing
b. Computer science
c. Applications of New Information Technology
d. The social relevance of New Information Technology.

a. Information processing

Learning to use information.

* skills:

- to be able to select data within the framework of a problem
- to be able to select information from data
- to be able to collect, store, process, present and distribute data and to be able to compose messages.

* Insight: into man's role in the provision of information.

- why does man need information?
- what does s/he do with information?

* Knowledge: of the techniques used in the production and search for information.
Some of this can be geared to the use of data processing systems.

b. Computer science

Learning to use the computer.

* Skills:

- to store, process, present and distribute data with the help of a computer
- to be able to select data needed to solve a problem with the help of a computer
- to be able to design algorithms which are necessary to enable the computer to carry out instructions.

* Insight into the phenomenon that computers are pieces of apparatus which are programmed or can be programmed.
Insight into the fact that although the use of computers brings

about a loss in flexibility, they also increase precision and speed.

* Knowledge of concepts such as computer, process, programme, algorithm, (micro)processor, memory, input, output, process-steering, data storage, data processing, programming language.
Knowledge of the principles of the structure of software and hardware.

c. Applications of New Information Technology
The development, applications, scope and limitations of New Information Technology.
* Skills:
  - to be able to use the most frequently occurring programme applications (word processor; databank (including data control); administrative programmes).
  - to be able to communicate with other computers, especially VIDITEL.

* Insight into the scope and limitations of the New Information Technology. Knowing in which situations information systems can be used.

* Knowledge of the historical development: "from abacus to all-round computer".
Knowledge of applications in:
  - office and bussiness
  - industry and commerce
  - traffic/transport
  - education and science
  - public institutions and authorities
  - leisure time/at home

and a knowledge of the occupations in New Information Technology.

d. Social relevance
The social relevance of New Information Technology.
The aim is that students learn to react adequately to the use of computers in society (a.o. by means of social skills, based on the correct knowledge of New Information Technology); that they gain insight into the consequences of the (potential) use of computers for man and society (insight into man's role in this).
This concerns knowledge of the social relevance in the present as well as in the past and the future, of:
  - the quality of work

- employment
- occupations
- the relationship male/female
- the relationship public/authorithies
- the relationship industrialised countries/ developing countries
- the effect on the environment
- war/peace.

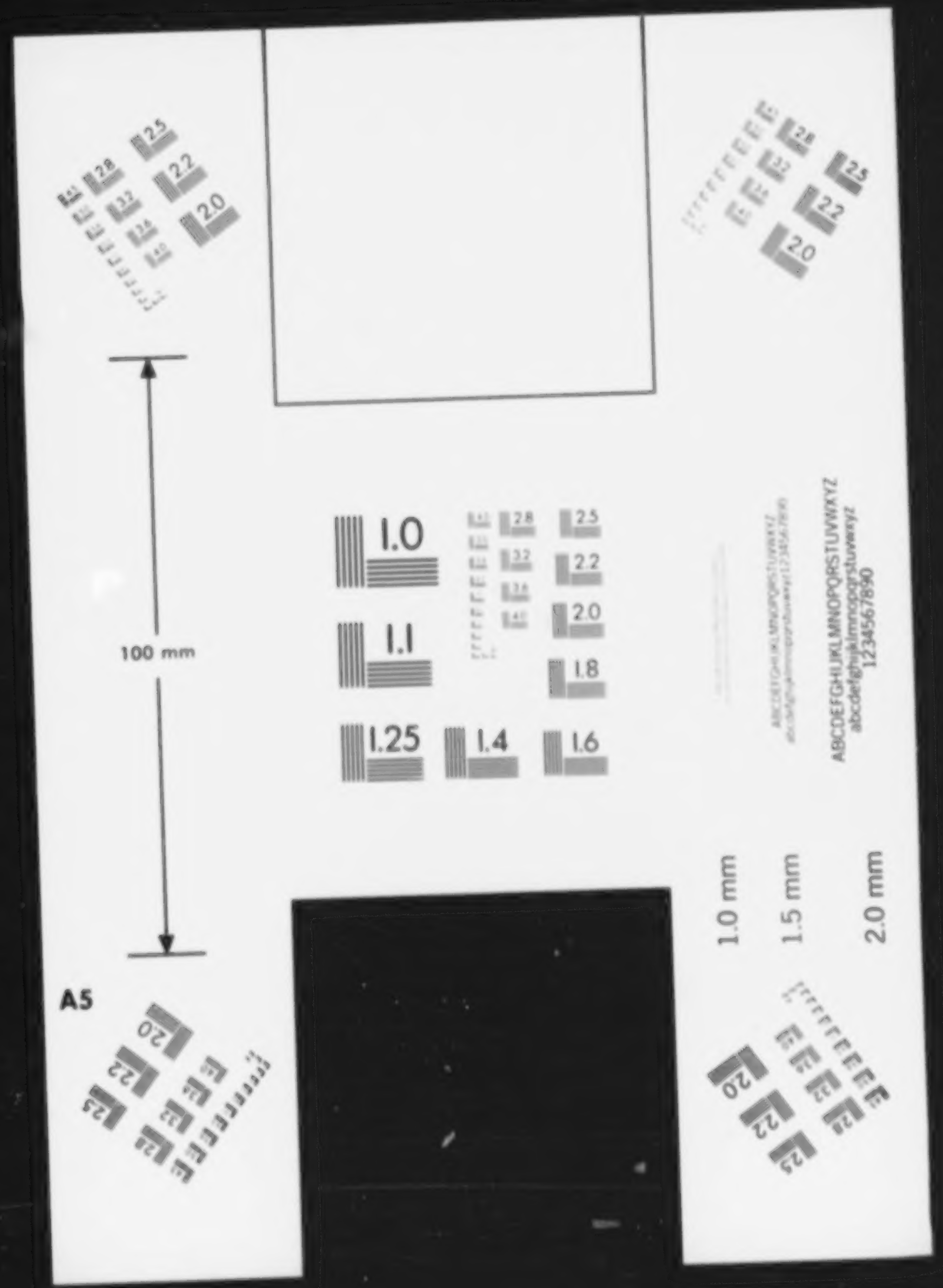
2.3. The situation in the schools

2.3.1. The design of technology in schools

More than 600 schools, largely lower vocational/technical schools, and multi-lateral schools encompassing technical (LTO), domestic science (LHNO) or agricultural education (LAO), have included General Technology in their curriculum. General Technology appears to have developed strong categoricalties. In addition the aims run far from parallel: General Technology as pre-vocational training and vocational guidance, also: as learning to use technology. General Technology is a collective name for what as far as aims and applications is concerned, are widely diverse introductory lessons in Technology in the first and second years of the category LBO, and in the multi-lateral schools LBO/LBO and AVO/LBO. From the individual school's point of view this varied interpretation is certainly useful. In global terms the following streams can be identified in order of quantity:

Group a: General Technology as pre-vocational training
The content of the subject indicates that the subject is used to maintain the vocational character in the second year.
The main or secondary aim is to bring the students into contact with the options available in the upper school, thus anabling them to make a better choice. The General Technology s set-up reflects the different possibilities the school has to offer.

Group b: General Technology as independent subject in lower vocational education (LBO)
A number of schools, starting out from different backgrounds and development, have come to an General Technology variant which attempts to acquaint students with the world(s) of technology.The difference between this type-a schools is, that there is little or no direct connection with the possibilities in the upper school. General Technology is an independent subject/learning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area.The breadth of the content and the aims is however closely related to the school category.

Group c: General Technology at multi-lateral schools for general secondary and lower vocational education (AVO/LBO)
Characteristic of this group is the forced development, often a lack of accomodation which is suitable for the new situation, and sometimes a lack of teachers of General Technology.As opposed to group b, where General Te'chnology is seen as an asset and impulse for innovations, multilateralschools AVO/LBO often General Technology as undesired subject: a subject with a vocational image, a subject which anticipates on determination (compare General Technology as option for students who have problems with foreign languages).

Group d: General Technology at schools participating in a project
Although there is also little conformity in schools participating in development projects (middle school experiments and integration projects for multi-lateral schools), this group of schools concentrates more on techniology as a cultural aspect. In some schools this is worked out in separate practical-situations: technical, domestic, agricultural and/or administrative practicals.

From the above we can draqw the following conclusions:
Two main types can be distinguished in the many variants:

- General Technology as a collective name for an introduction to Technology arranged in vocational sectors;
- General Technology as independent subject or learning area, with its own aims, which depending on the school category involved, get a smaller or broader interpretation.

In addition to the aims and contents, the circumstances also vary widely (rooms-teachers-forms of work-number of lessons).

At the beginning of the second period, the first step on the road to a national implementation of Technology and Care and Welfare, one should however take into account the limited structure and widely diverse begin situation in 1985.
The introduction of Technology and Care and Welfare is, given the differences in the design and development, and setting aside the limitations of a financial nature, a gigantic operation.
In addition the demarcation, c.q.relationship with regard to the developments in the field of New Information Technology will have to take place.

2.3.3 The design of New Information Technology in schools

In April 1983 about 100 schools for the education of 12-16 year olds were given the opportunity to obtain equipment for use in information theory. This was subject to certain conditions. One of these conditions was participation in refresher courses.

A first evaluation, in November 1984, presented the following picture:

- The choice of subjects in which Computer Studeies is integrated, in which it is applied or of which its forms part, appears to be determined primarily by the interests of the teachers. In addition the (presumed) relationship with certain subjects and the possible loss of lessons, play a role. All motives appear to be of a practual nature; there is little evidence of a fundamental choice.

  Nearly all subjects are mentioned, the most frequent are Mathematics, General Technology, Dutch and study periods. One can hardly speak of an integration with other subjects; Computer Studies is offered mainly as a seperate subject-area. In LBO schools, Computer Studies is offered mainly in the first and/or second year, in the AVO/VWO schools in the second and/or third year.

  During the first year of the project many schools had to contend with a shortage of lesson material.

  The material provided during the first year of the project received a negative reaction in most schools. The material provided by educational publishers, on the other hand, generally received a positive reaction.

  It is noticeable that some schools collect books, periodicals, video-tapes, films and software, with great inventiveness, while others more or less passively await what is going to be offered to them.

  Noted can be that the diversity of the ages and the levels of the students, and the variety of the aims, hamper the development of generally applicable lesson material.
- Most of the project schools criticized both the quality and the quantity of the refresher courses in the academic year 1983/84. Generally it was also felt that refresher courses should take place before actual participation in a project.
- In a number of cases teachers with a wider experience in Information Theory successfully organised courses for fellow-teachers.

- Opinions varied on the equipment made available to the schools. In particular the composition and the possibilities of networks (configurates)presented some difficulties.
- The number of computers which is presently available per room is insufficient. Experience shows that it is possible for two students to work at one computer, but not for three.
- As far as the ergonomic aspects of computer-use in the classroom are concerned, there is still much unclarity.

3. Integration: a proposal as starting point for further discussion

3.1. the concept of technology

The concept of Technology points to:
a. certain ways of human thinking and handling
b. the product of human thinking and handling.
It concerns processes and products.

Ways of thinking and handling become evident from working methods and skills used in teh extraction and processing of natural resources. Systems and instruments used to structure processes, to organize and to manipulate, are also based on special methods of thinking and handling.

The products of human thinking and handling are not only material products, such as utensils, manufactered goods, tools or installations, but also non-material products, theories, research instruments used by scientific researchers.
In linguistic usage, and therefore also in human thinking and handling, technology has a broader meaning. Technology applies to both products and processes, and to material and non-material matters.

In the world around us we see products of thinking and handling and ways in which people try to influence and optimize their life-style.
Expressions of this are:

- utensils
- the extraction, transport and applications of energy
- the availability and preparation of food-stuffs
- transport facilities
- buildings and housing
- means of communication, etc.

What people in our society think, do and experience is reflected in our culture. Per culture the effects of thionking doing and expering are different, depending on the needs which arise from a given situation and the resources and aids which are available. Examples of these differences are: the buildings of a people, a district, the eating habits, the application of manufacturing methods, the economic and monetary system, the way in which information is processed, etc. All these cultural components are also a result of the applications of technology and are closely interwoven with the social and the economic structure of society. On the one hand technology influences society and on the other hand society creates needs which invite the development and application of new technical products and working methods.
Through this man is being faced with the questions about the how and why of technical applications and has to consider the consequences of this for individuals, groups and society as a whole. Examples of this are: the discussion about energy, the mutual influences of man and technology in the field of Ergonomics.
Everyone come sinto contact with technology through the things which surround us, and which we use. We invent, make and use more or less complicated things as aids to or extensions of our own handling.

In most cases we are only the users of the things, they have been designed and made by others.Those who make things have not always invented themselves. Design, make-up and use as a coherent integrated whole, we can still find in children who are occupied in an expressive, formative or constructive way, in the do-it-yourself person, and in people living close to nature.
In our industrialized society, the design, make-up and use are generally three separate situations.
Products are usually made by, or with the aid of, very complicated machines, or by qualified specialists who have no part in the design. The public is often consumer without having any notion of the production and the process of development and invention. New products are invented and development by technicians, who are often not in a position to foresee all the consequences of production and use.
Because of the ever- increasing distance between the design, the making and use of the things, technology is increasingly being appreciated in contradictory ways: on the one hand with great admiration and expectation, on the other hand with a fear for threats and dangers. For example, admiration for bringing man to the moon, fear for the emplyment of space technology for war

purposes, high expectations of the possible use of computers, fear for loss of jobs, fear for lossof privacy,etc.
For the individual it becomes increasingly difficult to anticipate the scope of technical developments, because technology is becoming increasingly specific, life becomes more complex and the problems become more extensive.
Not everyone is aware of the fact that technology greatly influences and determines the current society in a socio-economic and cultural way. Technology is seen, experienced and valued in different ways, this depends on the scope of the technical developments which are anticipated, the manner in which one is confronted with technology (as user, maker or designer) and on the socio-economic and cultural norms and values one wishes to pursue.

In summing up a number of characteristics of technology can be given:

- technology is an integrated part of our culture as a whole, an expression of the thinking and handling of people in the present and the past.
- technology concerns the products, the things, as well as the way people think and handle.
- technology concerns artificial things, both material and non-material.
- technology manifests itself in the design, make-up and use of things, on the one hand as a stage of handling and on the other hand as independent handling situations.
- technology is value-tied: the design, make-up and use of things is directed at human aims, whereby questions can be asked about its value.
- technology influences society in a socio-economic way and vice versa.

3.2 The relationship man, technology, society and education

An interaction takes place between human possibilities and technical developments. Through this our society is influenced by technical developments and vice versa.
In this chapter we will look at the implications of this fact for the functioning of man as individual and as member of a community. Because education has to do with equiping man with the ability to function, it is of importance to indicate the role of education in this.

The functioning of our society is closely related to the make-up of things which can influence our human existence. Our socio-economic system is closely linked to the system of production, transport and consumption of goods which is based on several technological applications.
Two movements can be indicated in the relationship man, technology and society:

a. technical developments come at use and are attuned to the social life and personal well-being;
b. man seizes techniczl opportunities in order to improve his/her prosperity and well-being.

The first movement

A topical example of the influence of technology on the functioning of man man from a personal and society point of view, are the developments in the field of new information technology. Already it appears that in the near future information technology will have an explosive effect on the labour market, on the content of many occupations, on the arrangement of daily life and on determining the knowledge and skills which should be offered in education.

As a result of technical developments, technical resources are becoming increasingly complicated. It is becoming more and more difficult to assess the use of their resources, to get a picture of how they function, to use them and to anticipate the consequences. A ever-decreasing number of people is able to keep up with the explosive growth of technical knowledge. As a result the emotional distance or opposition to technology is increased for many. Others feel isolated or helpless because of their lack of knowledge and insight into technical developments. The idea that technology should not be accepted as an "autonomous variable" in the social process is gaining ground. Because of a political emancipation one no longer resigns to the autonomous development of science and technology. Examples of this are the discussions about social issues related to technical developments in the field of nuclear energy, micro-electronics and the bio-technology.
Technical developments have also started up social developments which in the near future cannot stopped or turned back, even if one wanted to. At most, everything can be done to equip man with the ability to deal with the problems arising from this.

The second movement

We can also, however, direct social developments to some extent, by applying technology in a specific way. The search for technical resources and applications of technology in developing countries is an example of the use of technology for improving prosperity and well-being, and for directing social change.

For man there is a great challenge to contribute to the improvement of a.o. communications, community health, production processes, working conditions and the environment, by means of technology.

But this also means that man has a great responsibility for the effects of technology on personal well-being and society.This means that man gives meaning to, or determines the purpose of the things he invents or makes. In this sense the design, the make-up and use of technical products is tied to values. In the first place this value-tiedness is expressed in the choices and in the priorities given to areas of life in which improvements c.q. changes are pursued. In particular this concerns areas such as environment, peace, safety, health, social and economic relationship and so on.

In the second place this concerns the norms which are being applied with regard to whether or not something is justifiable.A topical example of this is the discussion about DNA research. But also in everyday life questions rise about whether or not to use certain products. Examples of this are machines which use high amounts of energy, weedkillers and insecticides, artificial colouring and flavouring, unsafe equipment, provisions which costs job placements, and so on.

Seen from the aforementioned movements in the relationship man, technology and society, there are two types of situations for which everyone should be equipped in today's society. On the one hand one should be able to assess the consequential changes of technical developments and one should be able to adapt to new situations.

On the other hand one should posses the technical knowledge and skills, and should have developed an awareness of the norms and values which enables one to apply technology in a responsible way with a view to increasing the prosperity and well-being of all mankind.

In this lies an important task for education.

In relation to technology man is placed in two distinct situations:

a. learning to live with the consequences of technical developments;
b. influencing personal living conditions and social developments by means of technology.

Being able to function in these situations presupposes:

- insight into technical developments in relation to developments in society;
- the ability to adapt to new situations;
- technical knowledge and skills;
- an awareness of norms and values.

This means that man has to be equiped for this. This is an important task for education.

3.3 Technology in educational programmes

In this chapter we present some points of view for determining the most essential contents of technology in general education. In this we subscribve to those theories on education and learning which consider it to be of great importance that the object of learning is planned, structured and filtered in such a way that students can get the optimal benefit from eduation. (Feuerstein, 1982)

As opplsed to theories in which the greatest value is given to self-development and discovery learning, without any specific direction from outside.

Paying explicit attention to technology means that learning material should be characteristic of technology.

The characteristics of technology mentioned in chapter 3.2 are used as starting point for determining the essential contents of technology in general education.

On the basis of these we will look at the following:

a. the aims of technical thinking and handling, in relation to the value-tiedness of technology and the mutual influence of technology and society;
b. the characteristics of design, make-up and use;
c. methods ofg thinking and handling;
d. the nature and the characteristics of technical products, both material and non-material.

3.3.1. Purpose of technical thinking and handling

Technical thinking and handling is aimed at the solving of problems which arise from the strive towards changing (human) existence, to ease, or to improve it. The purposes of technical thinking and handling are expressed in the problem situations for which individuals or parts of society want to find solutions. One can only speak of a problem situatiojn when a situation is experienced as a problem, i.e. when there is a discrepancy between a desired and an existing situation. With regard to technology possible problem situations are:

- there is a need for a resource, a provision or a certain product, which is not yet available;
- a piece of apparatus, a machine, an installation which does not work as it should, a fault develops, a process runs differently to what desired.

An aspect of a problem situation is that in the development, make-up and acquisition c.q. use of technical products, the solution has to conform to your norms and values or to those of others.

For education there are a number of opportunities for starting out from a problem situation which can also be experienced by the students as a real problem. Some possibilities are:

a. link to current desires to make something e.g. utensils for use in the home, garden, kitchen, play etc.
b. create needs and thereby create problem situations e.g. by confronting them with the consequences of the use of phosphates, bringing them into contact with manufacturing and processing techniques of materials, by challenging them to apply biological and scientific principles and laws, by presenting students with a fault in a piece of apparatus or a machine etc.
c. simulate problem situations e.g. a simulation game about the production and use of fertilizers and the socio-economic consequences of this, "puzzles" and questions which arouse the imagination of students, a.o. use of computers, space travel, etc.

The choice of the type of problem situation strongly determines which aspects should be included in the content.

Attention should be paid to those contents which play a key role in the solving of the problem posed.

3.3.2. Characteristics of the design, make-up and use of the technical products

Design can be aimed at e.g. changing something which already exists, using esisting components to make up a new whole, developing new products without making use of existing or given components, etc. Characteristic of design in all these situations is, that the activities are related to the solving of a problem, whereby the solution has to conform to certain pre-determined demands.

Several starting points are possible in the making of things e.g. reproducing an existing product, or making somethinf on the hand of a design, or drawing. Making can also be aimed at making a product for which the final form has not yet been determined. Design and make-up are in direct interaction here. Finally making can form an extension of design e.g. s/he who is going to make the product has also designed it. Characteristic of all these situations is that the order of work has to be determined and in some cases also the way in which materials are to be manufactured or processed. This can present a problem if these situations are new to the maker. In that case the solving of the problems related to the order of work and the working methods are an essential characteristic of making.

A number of different starting points are also available for the use aspect:

a. use is an extension of design and make up;
b. someone seaks and selects technical products which serve his/her purpose;
c. someone in everyday life is confronted with products which have been designed and made for a predetermined purpose,but which can also be adapted for other purposes;
d. in the use of technical products certain situations arise where products do not live up to expectations e.g. through faults, inability to use it and so on.

The most significant characteristic of use is assessing the suitability of utensils. When this assessment has to take place in a situation which has not occured before, this can present itself as a problem.
The cionclusion that something does not live-up to expectaions can also present a problem. These situations repeatedly occur in a greater or lesser extent. Solving problems related to hte use of technical products is therefore also an essential characteristic of use.

3.3.3. Methods of thinking and handling

Technical thinking and handling is aimed at solving problems in the design, make up and use of material and non-material things.

In literature we find several models for a systematic approach of a problem. The similarities in these models, which have been developed for different types of problems, are great. Common to all these models is that the process of problemsolving is outlined in logical phases. The main phases are:
I orientation on the problem, problem analysis
II designing, searching for a solution
III drawing up a plan of action
IV execution
V evaluation, examination
These models are not meant to indicate how the process of problem-solving takes place in terms of time, but they do indicate what should happen in order to a good solution of the problem. During the process of working out a solution it often happe'n that one "jumps" to a further phase. Just as one will often go back to phases to make adjustments on the basis of new insights. Often the orientatio, serching, planning, execution and examination will also be repeated at each seperate phase.
The following phasing can be applied in the solving of a technical problem.

orientation	problem analysis developing possible solutions outlining possible solutions
research and development	reflection on possible solutions formulating hypotheses examining hypotheses optimization choosing the solution
realization of the solution	plan of execution execution evaluation and control

An important prerequisite for being able to solve a problem is that the problem situation, or the type of problem, should be chosen or worked out in such a way that it is not too complex or vague. The complexity can be decreased by clearly structuring the problem situation. Also by drawing attention to relevant information, or by referring to, or making use of resources for obtaining information.

3.3.4. The nature and characteristics of technical products

There is a great diversity in material things, they appear in several forms, such as:
things which are made from: natural materials , e.g. a vase, a boomerang, a basket, materials or raw materials composed of natural materials, e.g. flour, steel, synthetics, textiles; compositions consisting of manufactured or processed natural materials which are partly man-made, e.g. clothing, dairy produce, "chips"; static constructions, e.g. a shelving-bracket, a chair, a building, a bridge; pieces of apparatus and machines, e.g. domestic appliances, tools, cars, radios, computers, etc.
In the design, make up and use of these materials things, depending on the nature and the function of the product, some or all of the following matters are subject of thinking and handling;

- the qualities of the materials and/or raw materials;
- the form aspects, with a view to the function and aesthetical quality;
- the constructive aspects;
- the energy aspects (source, transport and conversion);
- the ruling and steering processes;
- the way in which data is signalled, registered and stored.

The non-material products of technical thinking and handling are usually materialised in graphic models and schemes e.g. a drawing of an electrical installation, a planning on a planning board, a scenario for the making of a product, etc.

Common characteristics of these models and schemes are:
they are made up of components with sub-systems of concepts and principles, they contain a set structure and they indicate the process progress.
In the design, composition and use of these non-material things are the subject of thinking and handling:

- the individual components/the sub-systems from which the model is built up;
- the structure with regard to the connection between the separate components, the whole system;
- the progress and predictability of the processes.

3.3.5. Summary

Starting point is that it is the duty of education to present a framework, to structure and to make choices for the content of education.
The technical thinking and handling is aimed at the solving of problems. A number of problem situations and several kinds of problems (specified according to content) with which everyone is confronted are mentioned. The problem situations and kinds of problems also determine which contents should be dealt with. Because it is the contents which should receive attention in order to be able to solve the problem.
Design, make up and use are seen as essential aspects of the content. In relation to this education should pay attention to the demands which are put to the solutions, the order of work and working methods, and to assessing the suitability. Problem-solving is seen as a very important objective of teaching and learning.
The most essential characteristics of technical products and therefore the most essential contents of education are considered to be:

a. with regard to material products:
- the qualities of materials/raw materials
- form aspects
- construction aspects
- energy aspects
- data signalling and storage
- ruling and steering processes;

b. with regard to non-material products:
- components
- structure
- process progress.

3.4. Technology in general education, a question of setting priorities.

The introduction of new contents in education means reflecting on what is being taught now. The existing contents have to

make room for the new ones or have to be taught in a more effective way, so that time can be made for the new contents. One lesson period can only be used once.
When a new subject or a subject area is introduced, or when more attention is given to Technology, other subjects or subjects areas will suffer, room in the curriculum for one goes to the deficit of another. Through the years an extensive and radical process for broadening education has taken place. The question is whether or not priorities should be set for what the content of education and the desired aims are concerned. As far as the setting of priorities within the field of technology is concerned, the following criteria are presented. General criteria for choosing the content, which are also valid for all other subjects and subject areas are:

- it should be dealt with at the school level, because of the actual function of the school today;
- it should contribute to the general education, c.q. the basic education of every citizen, also considering his preparation for the future;
- it needs to relate to the life and experience and the thinking and handling capacities of the students;
- the school should be able to offer it in an efficient manner in the given circumstances (size of group, available time, accommodation, etc.)

We will take a closer look at these general criteria and especially at technology in general education. In this the emphasis will be placed on the first criterium.

3.4.1. Functions of the school

What someone knows or is able to do is not only brought about by the school. There are many influential media outside the school which have an effect on the development of man on the affective, cognitive and psycho-motor level. Apart from the school, the family, age-group, reference and identification groups and persons, the mass-communication media, etc. also heve an influence. Now that more and more is being expected from the school, priority has to be given to the typical or actual functions of the school in relation to other persons and bodies that have an "educational" influence. The school differs from these others because of the possibilities she has for allowing young people to get experience in a systematic way, to train them and to pass on knowledge, to make them aware of norms and values. The school can do this by means of:

- structuring the (complicated) world around us and the knowledge in such a way that it is looked at in a certain manner;
- selecting those contents and learning activities which are considered to be of most relevance in the equipment and development of young people;
- programming the learning processes and by accentuating certain phases of the learning process;
- organizing educational learning situations, whereby influence is exercised, in a directed and planned manner, by the teacher and/or fellow students, with a view to changing behavior (= result of learning) on the affective, cognitive and psychomotor level.

3.4.2. To bring structure in the reality surrounding us

Modern technology presents itself on the one hand as theory and on the other hand as practice, whereby both aspects are related. This means that one should opt for those topics, those themes, or those subjects which could cover the content aspects of technology in the social context and which allow for an equal amount of theory and practice.

Themes which particularly lend themselves to this are:

- production (of a.o. food, clothing, tools and utensils)
- housing
- energy
- information
- transport
- communications.

With these themes one can link to experiences in everyday practice and they offer the opportunity for a theoretical and practical approach to natural materials, human needs, scientific laws and principles, political and economic aspects.

3.4.3. Selection of learning material

What is expected of education is related to the views on education which are influenced by political, cultural and pedagogical streams. The selection and choice of learning materials is therefore not value-free. This is also true for Technology.

In selecting learning material a disctinction can be made between:

- that which is considered to be of such great value in the cultural inheritance, that it must be passed on;
- that with which young people must be confronted, because in the development of technical thinking and handling its meaning cannot be neglected.

The transfer of and confrontation with, content aspects of Technology relates to:

a. systematized knowledge of aspects of Technology (both material and non-material) and of methods of technical thinking and handling;
b. instrumental skills for the design, make up and use of technical products;
c. values and norms with regard to technical thinking and handling.

Systematized knowledge aspects for transfer are:

- the basic concepts, principles and laws form the sciences;
- the concepts needed to be able to communicate about Technology: such as names, sizes, symbols and coding;
- the qualities of a limited assortment of materials and raw materials with a view to possible applications, production and processing, and maintenance/conservation;
- construction principles, static as well as dynamic, such as skilled work, profile formation, connections and changes in movement;
- the extraction, transport generation and application of energy;
- the recording, the processing and production of data into usable information, with the aid of a computer.

Instrumental skills which are of importance in the design, make up and use of technical products, and which have to be trained in school-like situations are:

- the ability to, starting out from a problem situation, consult various sources in order to find the information needed to solve technical problems; it is impossible to have knowledge and know-how at hand for all the different areas and levels of technical thinking and handling;
- the use of problem-solving methods, such as algorithms and heuristics;
- the ability to understand and use "technical language"; technology uses signs, symbols and methods of schematizing, a.o. projection drawings, graphics, models and so on;
- measuring and working to size.

In technical thinking and handling the ability to manupilate and process materials, and the ability to use and operate things play an important role. An introduction to a.o. the following skills should be possible in general education, while training in them should take place in other situations:

- re-shaping of materials a.o. by bending, kneading, pouring;
- changing materials a.o. sawing, filing, grating, cutting;
- joining materials a.o. knitting, weaving, sewing, soldering, welding, gluing;
- drawing, a.o. with the aid of drawing apparatus, by means of graphic techniques;
- operating pieces of apparatus a.o. for word processing, ruling and steering processes, data-processing.

Values

From the point of view of technical thinking and handling, in basic education expliciet attention will have to be paid to the transfer of the following values:

- safety (a.o. safety at work);
- accuracy;
- functionality (a.o. with regard to shape and colour);
- efficiency.

The transfer of values takes place a.o. by:

a. setting an example of what to do and what not to do;
b. using arguments in favour of certain values;
c. the setting of norms.

Technology induces, c.q. offers starting points for confronting students with a.o. the following value-areas:

- human needs;
- nature, creation;
- the socio-economic order;
- man and work.

Depending on the ideological direction of the school, norms will be transferred to or developed in the students with regard to:

- application of natural recources;
- respect for fellow-man, a.o. privacy;
- fair distribution of goods;
- intervening in life and death;
- etc. also determined by the way in which the school wishes to profile its (ideological) identity.

3.4.4. Accents on phases in the learning process

We start out from the assumption that education is aimed at the changing c.q. influencing of behaviour and that the following behaviour areas can be distinguished, whereby the learning processes are different, namely:

- the cognitive area: to come from not knowing to being able to apply knowledge which is stored in het memory.
- the psycho-motor area: to come from not commanding the ability to perform handlings, movement and movement patterns to being able to perform these automatically;
- the affective area: from not having an awareness, c.q. from rejection, to come to personal involvement and handling according to self-accepted norms and values.

Knowledge

Knowledge in the field of Technology can be structured according to the characteristics of technical products. In the process of acquiring this knowledge we can distinquish four phases of knowing, namely

- knowing that it exists

This knowledge is based on the concrete observable characteristics of the thing, i.e. the shape, the material from which it is made, the optical structure, etc. This also concerns the name of the thing and the names of the sub-aspects of it.

- knowing how and what to use it for

This knowledge concerns the meaning of the thing for man, the possible applications, the maintenance of it etc.

- knowing how it works, how it is put together

This encompasses the knowledge of technical principles which form the basic of the product, the relationship between the different aspects etc.

- knowing with a view to explaining

This concerns the theoretical explanation of the technological relationship including the underlying scientific knowledge.
In addition it encompasses the relationship with other technical products as well as socio-economic issues.

Psycho-motor skills

The manipulation and processing of material and the operation of pieces of apparatus presupposes the command of certain psycho-motor skills.
These skills can be reduced to automation as part or whole range of actions, e.g. sawing, knitting, rowing, driving a car, operating a crane etc. The learning process in the learning to auto-

mation generally goes through the following phases:

- being aware of the movement

The movement is made on the basis of the knowledge of the direction of the movement.

- fusion

A fusion of the perception, the awareness of the direction and the movement occurs by practice (the eye-hand coordination).

- automation

The movement becomes automatic.
Being aware of the movement can even be disturbing. The many kinds of handlings in the manipulation and processing of material and in the operation of pieces of apparatus induce a directed choice of a number of skills in movement patterns which form the basis of many handlings.

Attitude

Familiarity with technology, a critical attitude towards the effects of technology and feeling for the easthetic aspects, are some of the basic attitudes which have an influence on the acquisition and the use of technical products. Naturally this is taken into account when designing and making products.
The aforementioned attitudes are expressions of the technical, the ethical and the aesthetic values and norms which are often applied sub-consciously.
The acquisition of values, and from there determining which attitude to adopt, and norms to apply generally through phases.
The main phases are as follows:

- Being aware of.

Being sensitive to the existence of certain values by paying attention to them.

- Doing something about it.

Paying active attention to or reacting to values with which one is confronted.

- Being familiar with.

Accepting values, feeling involved and supporting these values.

- Taking a stand.

Come to the construction of a value system by means of processing values.

- Choosing c.q. handling on principles.

Embodying the values in the ideology.

3.4.5. Situations with directed influence by teachers and fellow-students

The direct contact between teacher and student offers an opportunity for immediate feedback on instruction, answers to questions and corrections. Direct contact between students makes it possible for students to function as information sources for each other and to react to each others way of thinking and handling for confirmation or rejection.
Precedence should be given to those content aspects in the school in which these special opportunities can be utilized.
For the teaching and learning of problem-solving (an essential characteristic of technology), interaction between teacher and student is indispensible. At many moments the teacher must be able to stimulate, direct and intervene. Example: exercises must be choosen or worked out in such a way that they are not too simple or complicated for the students. The acquisition and application of knowledge needed to solve the problem posed must be stimulated.
Questions should be asked and clues must be given to indicate the direction of possible solutions. The teacher checks and guides the student in the working out of the solution.
The school has exclusive opportunities for the teaching and learning of problem-solving. This is why it is justified to allocate an important or central place to problem-solving in the educational programme. In this as much as possible should be learned and practices on the hand of problem situations in which concrete situations and tangible topics can be used.

3.5. Summary

The introduction of new contents in education forces a review of the existing ones. When more and more contents have to be dealt with within the total time available, priorities have to be set.
a. resulting fromt the actual function fo the school
b. contributing to the necessary equipment of everyone (as indicated in chapter 3) i.e. general education
c. linking to the students
d. can be taught efficiently at the school, taking into consideration the possibilities and limitations in a school for basic education

With regard to the first mentioned criterium it is assumed that the school has its own typical function, which distinguishes her from other forms of education. As actual functions of the school, we mentioned bringing structure to the surrounding reality, selecting learning material for students, accentuating certain phases of the learning process and creating interaction situations.

Starting out from these functions we indicate those content aspects to which education in particular should pay attention.

This is worked out further in:

- suggestions for themes and aspects within thematic education to which attention should be paid so that technology in the social context can be dealt with;
- a summary of topics of systematized knowledge in the field of technology, instrumental skills and values. A distinction is made between knowledge, skills and values which have to be transferred, and those with which students should be brought into contact. The topics are selected from the point of view that students should have a certain basic knowledge and a command of certain basic skills, in order to have a base for the signalling and identification of technical problems.
- Priorities on the basic of phases in the learning process and the role of the school in this. In the learning process these priorities are different for the knowledge, the psycho-motor and the attitude level. It still appears to be impossible to indicate a number of skills here with regard to movement patterns which form the basis of many forms of handling.

Using the criterium general education means that in the first place precedence has to be given to skills and the ability to get information independently. Further, specifications are given for general methods for structuring the surrounding reality and for coping with that reality.

In the criterium that the learning material has to be linked to the student, three age groups are distinguished whereby the ages of 7 to 8 years and 11 to 12 years are seen as important turning points.

There are certain limitations but also specific opportunities for Technology in the school such as the availability of accomodation and equipment, the availability and use of audio-visual aids, the possibility for practical lessons.

The consequences of this for the choice of learning content are:

- "manageable" topics, or topics which lend themselves to school models, presentation by means of audio-visual aids or out of school activities

  - topics and contents which lend themselves to testing in practical situations, namely materials, constructions, connections, compositions/mergers of (raw) materials.

4. Policy recommendations

On the basis of the trends and developments signalled in chapter 2 and the proposals (or similar proposals) made in chapter 3 it is disirable that further policies are developed.

a. Policy recommendations, aimed at a greater amount of attention to Technology in general education (4-14 years olds).
  - mobilizing the education field, the public and politics for a discussion about Technology in education
  - promoting that by means of study, research and consultation, a responsible decision can be taken on the place of Technology in basic education in relation to attention which can be paid to other aspects of our culture
  - bringin about that Technology becomes compulsory subject, or at least receives attention, in general education
  - bringing about that legal arrangements are made for Technology to form part of the curriculum for the first two or three years of all secondary education

b. Policy recommendations, aimed to clarifying the content of Technology in general education (4-14 years olds).
  - promoting that in the implementation of Technology the opportunity is offered to gain practical experience in situations involving design, make up and use.
    systematic attention is given to problem solving
  - promoting that by means of study, research and evaluation resonsible choices can be made with regard to the specification of content aspects with regard to:
    knowledge of the functions and the characteristics of technical products;
    orientation on norms and values;
    training in and introduction to (motor)skills;
    offering different kinds of problems and problem situations differentiated according to age an ability groups.
  - promoting that an important accent will be placed on the ability to obtain information independently and applying

this information, and less accent on the transfer of reproducible knowledge.

c. Policy recommendations aimed at a consistent curriculum for the schools.

- promoting that the prerequisites are being fulfilled for the realisation of Technology as a broad learning area in general education
- promoting that developments in the field of technology as a subject are adjusted to technology as broad learning area
- bringing about that in the introduction and implementation of technology and the activities in the field of introduction and implementation of New Information Technology do not take place separately, or grow apart, but converge.

5. Literature

1. Advies burgerinformatica, Advies aan de Minister van Onderwijs en Wetenschappen, Enschede, SLO, 1985

2. Algemene Technieken, Raamplan onderbouw LBO, Amsterdam, VSLPC, 1977

3. Algemene Technieken. De relatie Mens en Techniek uitgewerkt in voorstellen voor de onderwijskundige inrichting van het onderwijs aan 12-14 jarigen/ Stichting voor de Leerplanontwikkeling., Enschede, SLO, 1982

4. Bergeijk, J. van, Onderwijs en de vraag naar de mens., Pedagogisch tijdschrift, 1983, okt., pp. 282-291

5. Bras, K. en C. van den Braber, Curriculumontwikkeling algemene technieken in Nederland., Den Haag, 1983

6. Burgerinformatica. "Verslag van door projectinspecteurs afgelegde schoolbezoeken en hierop gebaseerde beleidsaanbevelingen"., 's-Hertogenbosch, november 1984

7. Coggin, Ph.A., Technology and Man: the nature and organisation of technology in modern society., Exeter, Wheaton, 1980

8. Covent van scholengemeenschappen: Onderzoek naar de ontwikkeling van het vak AT op scholengemeenschappen., 1bo/1bo, 1979

9. Feuerstein, R. en B. Hoffman, Intergenerational conflict of rights: cultural imposotion and self-realization., Journal of the school and education, vol. 58, 1982, nr. 1

10. Jong, R. de, Naar een algemeen model voor probleemoplossend handelen binnen algemene technieken., Eindrapport van SVO-project 0490, Haren, RION, 1982

11. Kremers, H.M.J., e.a., Reacties en meningen vanuit scholengemeenschappen., VSLPC, 's-Hertogenbosch, 1981

12. Kremers, H.M.J. en A.J. Mulder, Innovatieplan algemene technieken (eerste ontwerp), 's-Hertogenbosch, KPC, 1981

13. Kremers, H.M.J., Algemene technieken: een wegwijzer., 's-Hertogenbosch, VSLPC, 1983

14. Kremers, H.M.J., e.a., Algemene technieken. Een handboek voor de oriëntatie op het invoeringsproces., 's-Hertogenbosch, VSLPC, 1984

15. Kwee, S.L., Denken in sustemen., Eindhoven, Technische Hogeschool, onderafdeling der wijsbegeerte en maatschappijwetenschappen., z.j., dictaat nr. 1.145

16. Leren over informatietechnologie: noodzaak voor iedereen/ Adviescommissie voor Onderwijs en Informatietechnologie., 's-Gravenhage, Staatsuitgeverij, 1982

17. Leune, J.M.G., Naar een verdere verbreding van onderwijsaanbod?, Pedagogische Studieën, 1983, nr.3, pp. 107-116

18. Melsen, J.C.J.M., Algemene technieken: overwegingen en aanwijzingen voor praktijkgerichte curriculumontwikkeling, Vianen, 198

19. Mulder, A.J. en W.G. van Velzen, Eerste fase voortgezet onderwijs in ontwikkeling. Suggesties voor het innovatiebeleid in de jaren tachtig., 's-Hertogenbosch, KPC, 1984

20. Nielen, G.C. en J.A. van der Pool, Over informatica onderwijs: een verkenning., 's-Gravenhage, Staatsuitgeverij, 1981

21. Op weg naar burgerinformatica: informatiebulletin project Informatica 4-19 jarigen/Stichting Leerplan Ontwikkeling., Enschede, SLO, 1982

22. Plomp, Tj., Onderwijskundige technologie: enige verkenning., Rede uitgesproken bij de aanvaarding van het ambt van gewoon hoogleraar in de onderwijskunde., Enschede, Technische Hogeschool Twente, 1982

23. Simon, H., The sciences of the Artificul., Cambridge USA, MIT Press, 1969 (Vertaald: Psychologie en systeemtheorie, Utrecht, Spectrum, 1976, Aula 569)

24. Rapport van de Studiecommissie Algemene Technieken, Amsterdam, VSLPC, 1974

25. Ris, B.G., Plaats en functie van het lager technisch onderwijs in nieuwe onderwijsstructuren, 's-Hertogenbosch, KPC, z.j., (medio 1972)

26. Techniek en Verzorging. Aanbevelingen voor een adequate ontwikkeling en introductie van techniek en verzorging in het voortgezet onderwijs (1ste fase)., Zeist, APVO-I, 1985

27. Techniek in het funderend onderwijs, 's-Hertogenbosch, NKSR-KPC, 1984

28. Technologische opvoeding: VSO-vademecum IX / Pedagogisch Bureau van het Nationaal Secretariaat voor het Katholiek Onderwijs VSO-coördinatie, Brussel, NSKO, 1978

29. Traebert, W.E. (Hrsg), Technik als Schulfach. Band 2., Technikunterricht im Spannungsfeld allgemeiner und beruflicher Bildung., Düsseldorf, Verlag des Vereins Deutscher Ingenieure, 1979

30. Traebert, W.E., Technik als Schulfach. Band 3. Lehren und lehrnen im Technikunterricht., Düsseldorf, Verlag des Vereins Deutscher Ingenieure, 1980

31. Traebert, W.E. en H.R. Spiegel, Technik als Schulfach. Band 1. Zielsetzung und Situation des Technikunterrichts an allgemeinbildenden Schulen., Düsseldorf, Verlag des Vereins Deutscher Ingenieure, 1982

32. Verder na de basisschool. Nota ter voorbereiding van een wet inzake de opzet en inhoud van een nieuw stelsel vervolgonderwijs, Ministerie van Onderwijs en Wetenschappen, 's-Gravenhage, Staatsuitgeverij, 1982

33. Wet op het basisonderwijs, Ministerie van Onderwijs en Wetenschappen, 's-Gravenhage, Staatsuitgeverij, 1982

34. Wielemans, W., Humanisering door techniek: zoeken naar eigentijdse onderwijsdoelstellingen op macro-niveau, *Nova et vetera*, 1973-74, vol. 11, pp. 322-356

THE THREADING OF A NEW EXPERTISE:
TEACHER TRAINING AND
COMPUTER-ASSISTED LANGUAGE INSTRUCTION (CALI)

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0. Introduction

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0. Introduction

Since a first problem in approaching this subject may well be the ignorance about the richness and variety of the CALI-field, we felt it necessary to devote a first part of this article to a short history of CALI. Language instruction, indeed, was one of the very first fields tackled by the introduction of the computer in teaching. The CALI-research, which has been done for more than two decades, must be our first source to determine and structure any appropriate teacher training materials. We used for this short history an updated summary of a previous presentation (Decoo, 1984a) and our general CALI-bibliography published last year (Decoo, 1984b).

But also other aspects require consideration before trying to circumscribe a CALI-curriculum for teachers. A number of preliminary obstacles, which tend to hamper any initiative from the onset, should be identified -- the second part of this article.

In the third part we will discuss the actual elements that could form a realistic basis for a teacher training program in CALI.

1. The emergence of CALI: a short history

1.1. First applications in the sixties

The first CALI-applications go back to the sixties. Adams, Morrison and Reddy developed programmed materials for the teaching of beginning German at the State University of New York at Stony Brook (Adams a.o., 1968; Adams, 1969; Adams and Rosenbaum, 1969; Morrison and Adams, 1968; Ruplin & Russell, 1968). The University of Stanford followed simultaneously with similar automated language instruction techniques (Crothers & Suppes, 1967). These early programs displayed verbal instructions and presented questions or exercises, accepting and evaluating answers, then branching into eventual further explanations for the weaker student, or into higher instruction for the advanced student.

A host of others emerged, especially in the United States. At the end of the sixties, CARLOS (Computer-Assisted Review Lessons on Syntax) was developed at the University of Dartmouth to correct assignments and increase practice opportunities. Similar programs were developed for French, German and Danish (Turner, 1970; Allen, 1972a, 1972b, 1972c). At the same time Virgil Poulter at the University of Texas introduced the use of the computer to score and print out the results of listening comprehension tests - this as CAI was already an integral part of their curriculum (Poulter, 1969). Also in 1969, Richard Barrutia published his "Language Learning and Machine Teaching", illustrating how branch programming can be conceived within a linguistic framework (Barrutia, 1969). Still that same year Raymond Lamerand published his "Theories of Programmed Instruction and Language Laboratories", in which one chapter was devoted to CALI.

PLATO must be mentioned as one of the most important pioneering projects in the late sixties and early seventies. During that period, PLATO, which then was in its early stages, carried secondary and college Latin, and beginning and intermediate French, Spanish, German, and Russian, utilizing a high-speed mainframe computer to teach various language skills to large number of students (see further). In 1970, the National Science Foundation sponsored the publication of an international reference guide on language and automation, with a section devoted to "machine-aided language learning" (Center for Applied Linguistics, Washington, 1970). A year later, Anna Maria Malkoc published as an ERIC-document a selective bibliography on CALI for the period 1967 to 1971 (Malkoc, 1971).

In Japan, the University of Tokyo has been involved since the end of the sixties in various forms of CALI-applications (Fujimura, 1969). In the United Kingdom, the Scientific Language Project at the University of Essex was probably the first European CALI-project, to develop the reading skill of foreign languages, in particular Russian (Alford, 1971). This ambitious and expensive project also worked with a mainframe computer. Elsewhere in Europe, at the dawn of the seventies, the initiatives seem rare, scattered and certainly not endowed with major means.

For most of these first generation CALI-applications, the transfer to language learning was clearly coloured by the basic CAI techniques of the time, by the use of mainframe computers, and by the principles of audio-methodologies. Nevertheless, their contribution to the field was significant as a pioneering endeavor. The exclusiveness of the field as a scientific première quickly encouraged a host of followers to start beavering away at CALI in the seventies.

1.2. Mainframe developments in the seventies

It would be very arduous to make even a summarized overview of all the CALI-projects and developments in the seventies. We will just mention a few, to give a taste of the academic engagement.

The University of Minnesota developed an important language program called CALLS (Computer Assisted Language Learning System) for Spanish. It allowed the student to choose from a very broad collection of exercises, storing comments and questions from the student and allowing direct communication with a group or an individual during the learning process (Clausing & Wood, 1974; Clausing, 1975; Langr & Seybolt, 1976). The famous Massachusetts Institute of Technology designed an interactive computer program to teach students read scientific German (Desch, 1973). It allowed the student to engage in a explanatory dialogue with the computer, so that drills, tutorial modes of instruction and general reviews were available at any point in the program. The American army and the CIA have been interested in the device since its early stages and they have been developing some highly sophisticated CALI-programs with major means (e.g. Kalikow, 1972, 1973). At Harvard, Tom Manwell conducted major research in CALI applied to Russian, collecting a large amount of critical data in the evaluation of CALI-programs (Manwell, 1973).

On the European side of the Atlantic, it seems that the United Kingdom has been on the CALI-foreground. The work of Rex W. Last is typical in this respect (Last, 1979a, 1979b, 1979c, 1980, 1982). Others conducting similar research and having published on the subject are B. Farmington at the University of Aberdeen (Farrington, 1981), Michael and Marie-Madeleine Kenning at the University of East Anglia (Kenning & Kenning, 1981), K. Ahmad and others at the University of Surrey (Ahmad, a.o., 1978a, 1978b), and Graham D. Davies at the Ealing College of Higher Education (Davies, 1980a, 1980b). There are many others in Britain. A register of current research on CALI is maintained by CILT (Center for Information on Language Teaching and Research) and regular conferences on the subject have been held since 1980.

In 1977, another selected, annotated bibliography on CALI was published in the CAL-ERIC series - an article by David Birdsong, sponsored by the National Institute of Education at Washington (Birdsong, 1977).

As to a concise evaluation of the general trend of the seventies, it appears from the many descriptions that quite a few of these applications, even produced by academic specialists, remain at the level of an automated quizzer, mainly using multiple-choice test items or gap-filling exercices, i.e. based on writing in letters or words. These applications are therefore geared towards conjugations, syntactical agreements, choice of articles, pronouns, prepositions, adverbs, particles, etc. (Balser, 1978; Collett, 1980, 1982; Haas, 1976; Langr, 1976; Lavine & Fechter, 1981; McKay, 1980; Smith, 1976; Terry, 1977a, 1977b). CALI-programs dealing with spelling and with word-by-word vocabulary training are also numerous (Atkinson, 1974; Collett, 1980; Engel & Andriessen, 1981; Keller, 1981; Kenner, 1980).

1.3. Towards a growing sophistication

- Enhancing the interaction

The better endeavors are characterized by a constant search for the full use of the interactive power of the computer. The traditional applications in presenting material and in receiving and immediately evaluating student responses are deepened by complex branching techniques, by which the sequencing, the timing and the practice are constantly adapted to the students' needs. An advanced research project at Stanford by Marian Beard and others dealt with such optimalization based on the profile of a student's previous performance (Beard a.o., 1975).

An important aspect of this individualization deals with the capability of the computer to self-generate a wide range of exercises, cutting short on practice where the goals have been achieved, but creating new exercices, with appropriate explanations and help, where the student fails. At Dartmouth, Scherr and Robinson worked out some broad strategies in this respect, with special emphasis on the structuring and coding of the data base for the learning of Russian (Scherr & Robinson, 1980).

Specific research in maximal interplay possibilities also led to other innovative features. Allee and Williams, respectively at George Washington University and at St John's University at New York, developed very simple routines to improve the personal interaction between the student and the computer, by allowing the student to input familiar contextual situations which the CALI-program automatically uses in its exercices (Allee & Williams, 1980).

At UCLA, John Underwood used the strategies of the ELIZA-type simulated conversation to develop the experimental Spanish CALI-program FAMILIA, in which a student can have an open-ended conversation with the computer about his family, practicing related grammar and vocabulary (Underwood, 1982).

- Turning decisions to the student

Based on various motivational studies, the input of free-choice is probably the strongest development in CALI. The research done at Ohio State by H. F. Taylor led to the abandonment of structured segments which the students were obliged to follow until a specific number of correct answers had been reached. More success was achieved if the students could choose to enter and leave segments at their own discretion and regardless of score (H.F. Taylor, 1979). Similar experiences at the University of Alberta led to the addition of a learning strategy component in their CALI-programs: students can choose what kind of help they want when working on a unit - grammar explanation in the foreign language or in the mother tongue, or a translation, or an extra exercice. Of course the students are also allowed to enter or leave a segment at any time - plus to type in critical comments or questions which are routed to the staff (McEwen, 1977). Fernand Marty has written with great emphasis on full-free movement in CALI-programs (Marty, 1981). A CALI-program should never become a weapon in the arsenal of the teacher, a rack to read the straight-jacked student aright.

- Improving error analysis

One of the most challenging aspects of CALI is the system by which the computer judges the response of a student and uses this judgment to help the student. The most primitive system of error analysis is the perfect match: the computer matches the student's response with the correct anticipated response or responses. In some very specific and simple CALI-programs, this binary approach can be useful. But already at the end of the sixties, the perfect match was abandoned in many of the better CALI-projects and new ways were developed, such as the partial match (Adams a.o., 1968), the pattern markup (Pusack, 1982a, 1983), error anticipation (Pusack, 1983; Marty, 1982).

Many researchers, however, have put their hope in an error analysis system based on the structure of the language. The system is often geared to parsing, when the aim is to have the computer parse the student's response in its morphological and syntactical constituents (Markosian & Ager, 1983). Here CALI converges with other areas of linguistic research linked to the computer (Urion, 1970; Decker, 1976; Nelson a.o., 1976; Allen, 1972a; Olmsted, 1975). In such programs, very clear-cut input rules still limit the application: although the use of artificial intelligence for the production and evaluation of natural language is in full progress, there are still a large number of restrictions. However, for well-defined CALI-programs, the parsing procedure seems to be the richest system in error analysis.

- Strengthening communicativeness

We also notice the evolution from drill practice, inspired by audio-methods, towards cognitive processes applied to lexical, morphological, and syntactic cells, and leading to practice in basic skills with a stressed semantic dimension. Reiner Schaeffer investigated the effectiveness of structural and semantic computer practice across two levels of verbal aptitude. He showed that retention is a function of the meaningfulness of the learning experience (Schaeffer, 1981). Somewhat in the same vein, Adler and Thomas developed a course in French transformational grammar by means of computer-generated video-tapes, with the goal not only to understand transformational processes, but also to develop language competence (Adler & Thomas, 1975).

- Using peripherals

More and more care is given to the format of presenting material. Indeed, many CALI-programs were developed for remediation, addressed to the slower learner, for whom the environment and the strategies must be very conducive to learning. Only presenting material on the screen in written format, like in a textbook, will often hamper easy comprehension. In the FRAND-program, the computer is connected to audio-cassette recordings and random access slide projectors to diversify the presentation of material (McEwen, 1977). Quite a few others followed in this direction, mainly combining microcomputers with videorecorders and monitors. The next step in this development was the introduction of the videodisc-combination, providing immediate free access to still and motion pictures with variable soundtracks (Schneider & Bennion, 1983).

In PLATO- and TICCIT-programs the same peripherals can be used, plus graphics and simulated movements. Although PLATO-courseware deals primarily with the positive sciences for American community colleges, it contains large foreign language sections for all European languages, for Latin and Hebrew, for Esperanto, for Hindi and Chinese, etc. An impressive amount of scientific work has been done and is still being done for the various CALI-programs in PLATO. Suffice it here to refer to a number of sources: Ariew, 1979; Bhatia, 1975, 1978; Cerri & Breuker, 1981; Chapelle & Jamieson, 1983; Cheng, 1981; Ching-Hsiang, 1976; Clancy, 1973; Cole a.o., 1981; Culley, 1979; Curtin, 1976; Dawson, 1981; de Montgomery, 1980; Dixon, 1981; Grundlehner, 1974a, 1974b; Hart, 1981; Kachru, 1981; Leidy a.o., 1980; Marty, 1975; Scanlan, 1971a, 1971b, 1980, 1981; Sherwood, 1981a, 1981b, 1981c.

TICCIT is an acronym for Time-Shared Interactive Computer-Controlled Information Television. The development started in 1971, extensively funded by the National Science Foundation, and scientifically developed by the Instructional Research and Development Department of Brigham Young University. The CALI-programs on TICCIT pertain to most European languages and some are currently being transferred on software for microcomputers (Judd, 1979; J.H. Taylor, 1979; Merrill, a.o., 1980; Hendricks, 1981; Stone, a.o., 1982; Decoo, 1985a).

- Measuring efficiency

Quite a large number of efficiency-studies have illustrated that CALI always results in higher retention, that it helps lowly motivated students to work on a higher level of concentration, that it boosts superior language students, yielding significant progress in various areas. The data supporting these studies are often impressive (Camstra, 1980; Curtin, 1981; Schaeffer, 1981; H.F.Taylor, 1979, 1982).

1.4. The democratization of CALI through the personal computer

The emergence and quick mushrooming of the personal computer since the end of the seventies has created a chaotic situation in computer-assisted instruction in general, but especially in CALI. Because of ignorance with the scientific endeavors in CALI and because of the earnest desire to make real courseware with the new toys, thousands of new producers are working out, painstakingly, their own primitive applications, earnestly reinventing the wheel, and often even presenting their reinventions as original endeavors. The democratization of the simple microcomputer has actually caused an enormous recession in CALI, confronting us continually with trivial productions.

1.5. State-of-the-art in the mid-eighties

All the preceding, of course, is still part of the present picture. But since a few years major efforts have been under way to coordinate the efforts, spread information, and improve the production. The following contribute to this:

- Organizations: we notice the threading of a complex network on national and international levels. It would lead us too far too identify all the organizations completely or partially devoted to CALI, but the CALI-Consortium 'CALICO' at Brigham Young University (Provo, Utah) deserves special mention, because of the scope of their means and their present impact. Their database (internationally reachable through DIALTWIG) includes now around 2,000 entries of projects and publications dealing with CALI. They sponsor the leading journal in the field (CALICO-Journal) as well as numerous sophisticated projects in the U.S.A. and elsewhere in the world. Through various international scientific channels, an inventarisation-project on CALI in Europe, in behalf of the CALICO-database, is being conducted on an ongoing basis (Decoo, 1985b).

- Symposia and conferences: the CALI-theme is surfacing with remarkable energy in international meetings around the world (AILA - Association Internationale de Linguistique Appliquée, with their national organizations following lead; also the International Conference on Computers and the Humanities - appropriately held this year, 1985, at Brigham Young University). CALICO itself sponsors a yearly conference entirely devoted to CALI, the last being held at Baltimore (1985) and yielding a remarkable harvest in international papers and reports.

- Publications: a number of books on CALI, but especially a growing amount of specialized articles, have been published this past two years. Several academic journals devote themselves completely or partially to CALI (see for a recent overview of these journals and an updated bibliography on CALI, Decoo, 1984b).

It will be clear from the preceding that a language teacher cannot just step into CALI and search his own way in the jungle. Help and guidance are urgently needed. These must be provided by following developments: 1. help the teachers make the acquaintance of the many sources presenly available; 2. the commercial spread of more sophisticated CALI-packages, running on simple computers and showing the real potential; 3. the advent of next generations of hardware and courseware, hopefully challenging the amateurs to much more interactive and communicative productions and simplifying the introduction to the field; and 4. the organization of training and the diffusion of critical reactions, original ideas and improving research through professional channels.

2. Obstacles to the introduction of CALI to teachers

2.1. Negative clichés and threshold fear
2.2. The turmoil of developments
2.3. The trivial CALI-programs
2.4. The sophisticated CALI-programs
2.5. Bad memories: the audio-revolution in the sixties

2.1. Negative clichés and threshold fear

It has already become a tradition, in lectures and articles on computer-assisted instruction, to speak about the computer-boom in education as an event of gigantic proportions. This is a suggestive, but not altogether harmless means to elicit certain reactions. One quickly wants to convince the public that the computer-boom in education is a mighty battering-ram and that those who are still standing by had better join in, less they would find themselves, within a few years, hopelessly out-of-date, and even illiterate. This fierce, suggestive propaganda, especially when directed towards a public from the humanities, may touch the wrong string. Its very character can cause those who jugde technology and automatization with fundamental suspicion or with the threshold fear of the outsider, to adopt a defensive attitude, just as fierce as the propaganda they are hearing.

Indeed, we should not forget that among many people anti-technology is a deep-rooted tendency, reinforced by clichés from literature and film. Technology is presented as threatening to civilization, to humanness. A number of language teachers will be influenced by such clichés. Added to this could be their ignorance about technology or their overestimation of its difficulty, causing a sometimes serious threshold fear.

The stumbling-block for some who have never worked with a CAI-program is the question: "Is computer-teaching and learning not inhumane?" The problem has been widely discussed in many publications. The user's experience shows that the computer, however paradoxically for outsiders, can fulfill a strong socializing function - the togetherness of several people discovering, playing on, questioning an interactive instrument. It is therefore recommended, certainly at early stages, to have students work two by two in front of a terminal or a stand-alone: in most cases this social insettling will help to befriend the computer.

2.2. The turmoil of developments

Moreover, the suggestive computer-propaganda is not in accord with the actually marketed achievements in CALI, as we have seen when discussing the impact of the personal computer. There still is a enormous gap between the proven potential of the computer in many educational areas, and the still searching, fermenting probings to implement this potential on a large scale in the area of language teaching. The turmoil of developments, both in hardware and software, makes the field difficult to assess.. I will not elaborate on the flashing developments in hardware, as the media provide enough echo's on this. As to the software, a wide variety of CALI-programs are being developed and implemented in many research centers, in numerous schools and computer-clubs.

Until the mid-seventies, articles on CALI in journals and compilations could all be analyzed carefully: since then it has become increasingly difficult to keep abreast with the tidal wave of CALI-publications, also because they appear in three divergent fields, linguistic, didactic, and technological. The proliferation of little projects and a fragmentation of the efforts shows that the journals specially devoted to CALI are far from being known by all CALI-amateurs. Finally, the rapid developments in didactically-oriented programming-dialects, such as e.g. Tutor and SuperPilot, or in specialized authoring systems, open perspectives which are constantly caught up by internal improvements or by new, revolutionary dialects.

2.3. The trivial CALI-programs

It would be a major mistake if someone were to evaluate CALI on a trivial product, encountered by chance in a school or at a computer-demo. Whoever went through one or two amateur CALI-programs, cannot give an evaluation of CALI as such, because he has only seen a minimal fraction of an instrument with a thousand faces and an unpredictable future. It is a fact that many existing CALI-programs are rather weak: often made by computer-freaks with an amateur programming-knowledge and thus able to include pleasant interaction-gadgets and irrelevant graphics, bells and lights, these programs not seldom show poverty in their very content, because of inadequate application of didactic criteria. Such criteria include, among others: relevance in content; adaptation to the student's initial situation; taxonomical progress as to the degree of difficulty and the level of skills; dynamic balance between the use of the mother tongue and the target language; maximal interaction to optimalize skill training, etc.

Those who judge CALI on a single product, have no idea of the vast possibilities of CALI in unexpected areas such as simulated conversations, combinations with video-programs, creative writing, etc. It would do CALI gross injustice to think it only provides structuralist grammar drills, single word vocabulary tests, spelling exercices, and Cloze-test-type writing practice. As David Sanders and Roger Kenner have pointed out rather mercilessly, CALI may suffer a similar fate as the language laboratory in many schools, because the type of courseware being mostly run on it is "sterile, boring, lifeless and ultimately of little use to language learners" (Sanders & Kenner, 1983).

Especially harmful to the future of CALI are those teacher-computer freaks who demonstrate their little CALI-courseware at inservice programs or at academic conferences: their work is practically always in the naive structuralist tradition - SR type drills, simplistic answer matching, automated branching techniques without student control, time consuming gadgets, and automated right-wrong evaluation of the results. All this may look nice to the layman and may even be productive according to certain limited objectives, but it remains trivial and no longer matches many new insights in language learning; it is not CALI in its full potential, as a relevant, communicative, and multi-faceted language learning system, adaptable to all kinds of specific methods and courses.

2.4. The sophisticated CALI-programs

However, at the other end of the spectrum, this fully developed CALI may also create an obstacle to a positive teachers' attitude. In the wake of the strong academic CALI-endeavors of the seventies, a number of very sophisticated CALI-programs have found their way to privileged institutions and organizations. These programs are usually top-scientific projects, based on huge resources, and dependent on the best of actual high-tech: videodisk, laser-implementation, immense computer-memory, digital speech, etc. Moreover, they continually improve and expand. However impressive, such programs can only draw smiles from teachers if the suggestion is made to implement this technology in regular schools. Even more affordable programs of higher quality, like PLATO and TICCIT, remain completely outside the reach of most of the educational system. Teachers who are interested in CALI face the struggle to get just a few simple personal computers at their disposal, and even that struggle is often still unsuccesful.

Between the cheap trivial programs and the highly expensive and sophisticated programs, there is a medium range still to be expanded: affordable programs of a better quality able to run on simple personal computers.

2.5. Bad memories: the audio-revolution in the sixties

Many language teachers who were already in the profession in the sixties and partially in the seventies went through that rather traumatic experience called the audio-revolution. Audiolingual and especially audio-visual methods had been hailed as the final answer to language learning. The technological assets of tape-recordings, language laboratories, and visual aids like slides, would bring about the miracle. All former methodologies were swept away in a wave of rather political and commercial slogans. Later came the disappointments and the bitterness, when the weaknesses and the unproven character of the assumptions were revealed. It left many teachers with a deep distrust towards miracle methods and especially towards technological wondertools. This distrust, no doubt, could still affect a large number of older teachers when they hear about CALI.

But CALI is something very different, compared to the audio-revolution. First of all, CALI is developing itself within the framework of the Third Industrial Revolution, which in its present super-chip state is even referred to as the Fourth Industrial Revolution. It makes CALI a fractional part of an extensive movement touching the whole of our society.

A second difference lies in the fact that the audio-revolution was, educationally seen, an independent phenomenon, limited to language learning. CALI on the other hand is part of a large instructional movement, i.e. computer-assisted instruction (CAI) as such. CALI can draw on the vast research and experience of CAI in all other areas. Language learning may have some peculiar aspects, but quite a few fundamental technical and didactic criteria are common to all subject areas.

A third main difference with the audio-revolution constitutes the fact that a quarter of a century has elapsed. Especially since 1965, language teaching and learning has known a remarkable scientific boost, which it owes to the reaction against the extremes of the audio-methodologies. More than ever we have come to the ascertainment that the variables for succesful language learning are complex and fragile and that every succesful method is bound to specific situations, specific teacher personalities, and specific students. In this respect CALI is not a method, but a complex of possibilities, with adaptiveness as its first and major characteristic.

A last difference is to be found in the fact that the audio-developments in the fifties and sixties were directed in rather centralized ways by a few strong nuclei, thanks to a happy marriage between a few publishers and educational systems, privileged by favorable political and commercial circumstances. The computer boom in education, however, provides us with this turmoil of developments we already mentioned.

3. Elements for a CALI-curriculum in teacher training

- 3.1. Towards a realistic setting and scope
- 3.2. A tentative curriculum overview
- 3.3. Should a language teacher learn to program?

3.1. Towards a realistic setting and scope

This very year, 1985, Brigham Young University, home of the international CALI-Consortium (CALICO), of TICCIT, of sophisticated interactive video-projects, announced its plans to offer a Ph.D.-program especially geared towards CALI. This is an exciting development, for the need for experts is great. A similar development would be most welcome at a number of European universities. Such experts could be our prime source-persons for a basic training in CALI to every prospective language teacher on a realistic level and in balance with the whole curriculum. Indeed, we cannot expect all language teachers to become experts in CALI.

Within the framework of the whole training a reasonable place should thus be given to an introduction to CALI, stressing the fundamentals and providing sufficient critical insight so that language teachers could stand firm in the turmoil of developments and could evaluate the practicality of CALI in a specific school-setting.

3.2. A tentative curriculum overview

The following overview contains a structure of elements that should be covered in a CALI-curriculum. The depth of each depends on the possibilities of the concerned program. In a curriculum providing only a few hours to CALI-introduction, these elements could still be treated in a compressed form and a selected bibliography should be provided to the prospective teachers. If more hours are available, some elements could be given in a more expanded format, according to the specificity of the teacher training concerned.

A. CAI and CALI - the general perspective

1. Aims and functions of mediational education
2. Versatility of CAI in teaching and learning processes
3. Criteria for implementation

B. Didactic conceptualization of CALI

1. Methodological orientations

   (relation to theories and methods; implications for design; dynamism between first instruction, practicing, remedial instruction, and remedial practicing; etc.)

2. Relation to didactic settings

   (independent courseware; textbook-tied courseware; etc.)

3. Subject-matter orientations

   (elemental or global lingual approaches; developmental lingual approach: interaction between elemental and global approaches and transferability to communication skills; taxonomization of practice-forms; self-generative practice; etc.)

4. Interactive patterns

   (forms; scope and limitations of free-choice; criteria for selection; etc.)

5. Error-analysis (forms; criteria for selection; etc.)

6. Student-evaluation

   (forms and limits; affective factors; timing; etc.)

C. Framing CALI

- overview and suitability of programming approaches

1. Programming languages
2. Authoring languages
3. Authoring systems
4. Hybrid systems

D. Efficiency and evaluation

1. Internal efficiency

   (criteria for strategy-selection: CALI or not?; criteria for course-ware evaluation)

2. External efficiency

   (financial planning; scheduling; etc.)

E. Affective objectives

1. Improving student's attitudes towards CALI

2. Steering the interaction between student and machine (sensory relation, keyboard-disposition, keyboard-functions, touch-sensitive screens, cursor-mastering, etc.)

3.3. Should a language teacher learn to program?

We agree that some acquaintance with the principles of programming languages gives an interesting background and that in our time every person involved with computers should have received this. However, real proficiency in such languages should not be a requirement for anyone except for actual programmers. Moreover, a general introduction to programming should more be geared towards general reasoning and problem-solving techniques, rather than to hands-on programming in symbols. The reasons for this are:

- The time investment to become proficient in a programming language is out of proportion to the teacher's other responsibilities; programming is a profession in its own right and should be used as such.

- People who need the computer for their research or even for the actual production of software or courseware, like CALI, should first learn to envision their needs and their wishes according to independent criteria, and not according to the possibilities of a programming language. Indeed, if they are somewhat proficient in a programming language, they will tend to make their vision subject to their programming ability (which usually remains rather elementary). Instead they must learn to formulate their vision without outside limitations. The implementation of the vision in a programming language is the professional responsibility of programmers, who must be able to respond to the most complex requests. Only if certain requests cannot be answered at all, should the researcher adapt to what is possible.

On the other hand, this does not exclude any candidate from acquiring real proficiency in one or more programming languages, if this proficiency would really serve a specific purpose (e.g. development of author systems) or if it would strengthen the person's place on the professional market.

- Programming languages are in constant evolution and have a common tendency to become obsolete. We notice a constant development towards new programming systems that are both user-friendly and sufficiently versatile. Especially the emergence of new authoring systems for education will make the arduous learning of a programming language completely unnecessary.

4. Concluding remarks

4.1. The need for expert teams

CALI requires at least trivalent specialists, not only to produce it, but also to introduce it to teachers: namely in the programming, educational, and linguistic fields.

The traditional gap between the educational and linguistic fields is well known. Prominent linguists, such as Bloomfield, Chomsky, Mackey, Barrera-Vidal, Bolinger, and others expressed their deep scepticism as to the benefit of linguistic insights for language learning. However, this does not mean that, for the development of a CALI-program, one could do without a thorough knowledge of the target language, of instrumentalized objectives, of a choice and a structure of content, of difficulty degrees and skill levels, etc. Therefore, we ought to rephrase the definition of 'specialist in linguistics' in this didactic context.

Next we have the proper educational input. Here we need a specialist able to work in terms of learning models and didactic strategies which are to be imposed on the computer programs. Since there is no generally accepted normative model for the learning process, and since didactic strategies show a great variety, there will be a broad spectrum of possible applications. The educational criteria will also determine the fundamental choice between a program-directed or a student-directed learning process, and the degree of internal generativity of the program by the building in of data bases. A broad field for investigating and experimenting is still open here, in assessing the correct relations between CALI-modalities and all possible learning models.

Finally, we need the proper programming in a computer language. In microcomputer based systems, this is not a last resort addition, because practicality asks that we know from the onset what the limits of the concerned computer system and the concerned computer language are. CALI-courseware, indeed, is usually meant for schools where only a micro system is available. The present democratisation of the computer may be due to the disengagement out of the mammoth systems which allowed the early CALI-programs to plan complex applications freely, but now it obliges the programming to be restrictively present, when the linguistic and educational aspects are being considered.

In reality it is not so simple to have specialists from the three areas work together on a specific CALI-project, and one seldom finds one man thoroughly acquainted with each of the three areas. There are a few, but not enough to have a significant impact on the development of many excellent CALI-programs. The few succesful combinations remain limited to research centers, where the facilities are so large, that the possibility for implementation on a large scale become very small. On the other hand, one should note a growing movement at the bottom. Some language teachers, who master their subject and who have teaching experience to draw on, are getting well-versed on their microcomputer. They sometimes produce remarkable CALI-programs which run on simple hardware.

4.2. The danger of a widening gap

There is a risk that the gap between the technological world of engineers, programmers, computer companies, and software producers on the one side, and the instructional community on the other side, is widening quickly. An uncontrolled boom in "exciting" language packages is probably on its way, eventually coupled with the development and commercialisation of audio- and video-components in micros. The ongoing story of computer-games, with their incredible expansion and their growing sophistication, is a case-in-point.

Such a development, outside the instructional community, can have consequences in two opposite directions. On the one hand, the poorly constructed language packages, in naive and expensive formats, will disappoint the public, and so contribute to negative feelings towards foreign-language learning. And, what is worse, the instructional community may get the blame.

On the other hand, excellent language packages may come on the market, because an intelligent commercial enterprise will hire the necessary didactic expertise - a fruitful marriage of interests. If the instructional community will know how to use and integrate these materials into their curricula, we may all profit from CALI. However, if the profession will be indifferent, it may find itself isolated from the action-field of foreign language learning. This is not a cheap prediction: we can already see how multi-nationals and large firms are organizing their own instructional cells for foreign languages. In this respect the constantly shrinking space for foreign language teaching in the regular school system is a sign on the wall.

4.3. Recommended strategies

It seems therefore important enough that language educators get more involved in the construction and control of this tool, which cannot be dodged any more and which carries enough promises to deserve full attention. In order to ensure its optimalisation, the areas to concentrate on seem: better information on CALI to diminish negative attitudes and misconceptions among the profession itself; consumer advice as to micros suitable for CALI; democratisation of programming through practicable languages and instructional drives; research and training in didactic principles related to the maximal potential of computerized interaction; stronger coordination between the people involved; development of software adapted to specific regular courses; and thorough in-service teacher training.

CALI is not promising utopia for a near future, but there are utopian elements in it, and it is wise to be aware of this potential. The videodisc technology with its immediate random access to still and moving frames and its multiple sound-tracks offers rich possibilities in connection with the computer. The advancing research in artificial intelligence will open up new ways for improved error analysis of creative utterances. Synthetic speech and compressed digital speech are making daily progress and their extended use in CALI is already predictable.

Quick and short-sighted judgments of people unfamiliar with the computer-world may sometimes present CALI as part of Brave New World. However, there is little risk that this will happen, if these very people will take a minimal interest in CALI and help it, even by their positive criticism, to achieve its goals - to improve multi-lingual communication around the world.

References

Adams, E. N., "Computer-based instruction and management in foreign language teaching: A systems concept", IBM no. RC-2658 (New York: IBM, Watson Research Center, 1969).

Adams, E. N., H. W. Morrison, and J. M. Reddy, "Conversation with a computer as a technique of language instruction", The Modern Language Journal, LII (1968), 3-16.

Adams, E. N. and P. S. Rosenbaum, DLI-IBM joint feasibility study in computer-assisted foreign language instruction. Final Report (New York: IBM, Watson Research Center, 1969). (ERIC: ED 032 542).

Adler, A. and Jean Jacques Thomas, "Teaching French transformational grammar by means of computer-generated video-tapes", Paper presented at the International Conference on Computers and the Humanities (Los Angeles, California, 3-6 April 1975).

Ahmad K., M. Colenso and J. M. Edwards, "Developments in computer assisted learning for Russian", Russian Language Journal, XXXII (1978a), 37-42.

Ahmad K., M. Colenso and G. Corbett, "On the teaching of Russian numerals by using an on-line computer", ALLC Bulletin, VI (1978b), 235-241.

Alford M. H. T., Computer assistance in learning to read foreign languages (Cambridge: Literary and linguistic Computing Center 1971).

Allee, J. G., and R. L. Williams, " A challenge for the language arts CAI developer", Creative Computing, VI (1980), 120.

Allen, J. R., "Current trends in CAI", Computers and the Humanities, VII (1972a), 47-55.

Allen, J. R., "Individualizing foreign language instruction with computers at Dartmouth", Foreign Language Annals, V (1972b), 348-349.

Allen, J. R., "The use of the computer in drilling", Die Unterrrichtspraxis, V (1972c), 31-35.

Allen, J. R., "A bibliography of computer-assisted instruction", System, I, 2 (1973), n.p.

Ariew, R., "Teaching French on PLATO IV", System, II, 1 (1974), 1-7.

Ariew, R., "A diagnostic test for students entering a computer-assisted learning curriculum in French", Computers and Education, III (1979), 331-333.

Ariew, R., "A management system for foreign language tests", CAL 81, Selected Papers, vol. VI (1982), 118-124.

Atkinson, R. C. and M. Raugh, An application of the mnemonic keyword method to the acquisition of a Russian vocabulary, Psychology and Education Series, Technical report No. 237 (California, Stanford university: Institute for Mathematical Studies in Social Science, 1974).

Balser, J. R. and S. A. Blice, "Computer games for the German Class", Unterrichtspraxis, XI (1978), 95-96.

Barrutia, R., Language learning and machine teaching (Philadelphia: Center for Curriculum Development, 1969).

Beard, M., a. o., The improvement and individualization of computer-assisted instruction: Final report (California, Stanford university: Institute for Mathematical Studies in Social Science, 1975).

Belmore, N. F., Language teaching research and the computer (Stockholm: Swedish council for Social Science, 1975).

Bhatia, Tej. K., "New directions and issues in computer-assisted instruction", Paper presented at the International Conference on Computers and the Humanities (Los Angeles, California: 3-6 April 1975).

Bhatia, Tej. K., "Computer-based Hindi pedagogy", Paper presented at the annual meeting of the Linguistic Society of America, LIII (Boston: 28-30 December 1978).

Birdsong, D., Computer-assisted and programmed instruction in foreign languages: A selected, annotated bibliography, CAL-ERIC/CLL series on languages and linguistics, No. 50 (Arlington, Va.: ERIC Clearinghouse on Languages and Linguistics, 1977).

Bolinger, D., "The influence of linguistics: Plus and minus", TESOL Quaterly, VI, (1972), 107-120.

Camstra, B., Leren en onderwijzen met de computer (Leiden/Antwerpen: Stenfert Kroese, 1980).

Center for Applied Linguistics, Washington, Language and automation: An international reference publication, No. 1 (Washington, D.C.: Language Information Network and Clearinghouse System, 1970)

Cerri, S. and J. Breuker, "A rather intelligent language teacher", Studies in Language Learning, III (1981), 182-192.

Chapelle, C. and J. Jamieson, "Language lessons in the PLATO IV system", System, XI (1983), 13-20.

Cheng, Chin-Chaun and B. Sherwood, "Technical aspects of computer-assisted instruction in Chinese", Studies in Language Learning, III (1981), 156-170.

Ching-Hsiang, Chen and Chin-Chuan, Cheng, "Computer-assisted instruction in Chinese: An interim report", Journal of Chinese Linguistics, IV (1976), 278-298.

Clancy, P., "A visit to the PLATO computer teaching project for French", Babel, IX (1973), 13-17.

Clausing, G. and C. Wood, "The computer-tutor in media-aided language programs", NALLD Journal, VIII (1974), 11-20.

Clausing, G., "The individualized dimension and media-aided language programs", System, III (1975), 1-9.

Clutterbuck, M., "The computer in foreign language teaching", Babel, XV (1979), 33-37.

Cole, P. a.o., "A computer-assisted program for the teaching of modern Hebrew", Studies in Language Learning, III (1981), 74-91.

Collett, M.J., "Examples of applications of computers to modern language study", System, VIII (1980), 195-204.

Collett, M.J., "Examples of applications of computers to modern language study. 2. Storage and retrieval: the development of an index of learning resources", System, IX (1981), 35-40.

Collett, M.J., "A tenses computer program for students of French", Modern Language Journal, LXVI (1982), 170-179.

Cooper, T. L., "Bread and butter CBI: The philosophy and design of a system", System, III, 3 (1975), 190-197.

Crothers, E. and P. Suppes, Application of mathematical learning theory and linguistics to second-language learning, with particular reference to Russian (California: Stanford University, Institute for Mathematical Studies in Social Science, 1967).

Culley, G. R., "Two-pronged error analysis from computer-based instruction in Latin", Paper presented at the Delaware Symposium on Language Studies (18-20 October 1979).

Curtin, C. a.o., "The Plato System: Using computer to teach Russian" Slavic and East European Journal, XX (1976), 280-292.

Curtin, C., "Computer-bases analysis of individual learning characteristics", Studies in Language Learning, III, 1 (1981), 201-213.

Davies, G. D., "New technologies for linguists", Computer Age, IX (1980a), 23-26.

Davies, G. D., "Learning German by computer at Ealing College", CALNEWS, XV (1980b), 5-8.

Davies, N. F., "A testing and feedback project using a desk computer", System, I, 2 (1973), n.p.

Dawson, C. and P. Nolen, "PLATO Sitcom dialogs for Russian" Studies in Language Learning, III (1981), 92-97

Decker, H. W., "Computer-aided instruction in French syntax", Modern Language Journal, LX (1976), 263-267.

Decoo, W., "Computer-assisted language instruction: Scientific basis and extension potential", in W. Knibbeler & M. Berbards (eds.), New approaches in foreign Language Methodology (Nijmegen: University of Nijmegen, 1984a), pp. 83-92.

Decoo, W., "Bibliography on computer-assisted language instruction", in Decoo, W. (ed.), Computer and language instruction: Applications of interactive technology, ABLA-Papers no. 8, publication of the Association belge de linguistique appliquée (Brussels: ABLA, 1984b), pp. 159-201.

Decoo, W., "An application of didactic criteria to courseware evaluation", Calico- Journal (U.S.A.), II, 2 (December 1984c), 42-46.

Decoo, W., "CALI in Europe: Inventarization project", paper delivered at the 2nd CALICO-Conference, Baltimore (1985a). To be published in the CALICO-Journal.

Decoo, W., French Verbs Program on TICCIT, CTS Technical Report, n° 11 (Provo, Ut: Computer Teaching Services, Brigham Young University, 1985b).

De Corte, E., "Computers en leren op school", Rapport no. 29, Departement Pedagogische Wetenschappen (Leuven: K.U. Leuven, 1983).

de Montgoméry, M. P., "L'enseignement des langues étrangères dans le système PLATO IV", Recherches et Echanges, V (1980), 101-112.

Desch, S. H. Jr., An interactive computer aid to reading scientific German (Cambridge, Massachusetts: Massachusetts Institute of Technology Press, 1973).

Dixon, R., "PLATO reaches international students with English lessons", Studies in Language Learning, III (1981), 98-112.

Dodge, J. W., "Machine-aided language learning", in E. Birkmaier, ed., Britannica Review of Foreign Language Education, vol. I (Chicago, Ill.: Encyclopaedia Britannica, 1968), pp. 311-341.

Engel, F. L. and J. J. Andriessen, "Educational technology research: Computer-aided learning of a foreign vocabulary", Educational Technology, XXI (1981), 46-53.

Farrington, B., "Perspectives for computer based learning of languages", Modern Languages in Scotland, XXI (1981), 116-124.

Farrington, B., "Computer based exercises for language learning at university level", CAL 81, Selected Papers, vol. VI (1982), 113-117.

Fujimura, O., "Technological developments for language learning", Paper presented at the Second International Congress on Applied Linguistics (Cambridge), 11 September 1969.

Grundlehner, Ph. E., "Computer-based education: PLATO in German", Die Unterrichtspraxis, VII (1974), 96-105.

Grundlehner, Ph., "PLATO: German reading, English as a second language, and bilingual education", System, II, 2 (1974), 69-76.

Haas, W., "The potential and limitation of computer assisted instruction in the teaching of foreign languages", Paper presented at the Annual Meeting of the American Council on the Teaching of Foreign Languages (New Orleans, Louisiana) 1976.

Harrison, John S., "Applications of computer technology in foreign language teaching and learning", in R. G. Mead, ed., The foreign language teacher: The lifelong learner (Northeast Conference on the teaching of foreign languages, 1982), pp. 143-151.

Hart, R. S., ed., The PLATO system and language study, Special issue of Studies in Language Learning, III (1981).

Hendricks, H. H., "The TICCIT System at Brigham Young University", CTS Technical Report no. 10 (Provo, Utah: BYU Division of Learning Services, 1980).

Judd, J. M., "Authoring procedures for TICCIT", CTS Technical Report no. 3 (Provo, Utah: BYU Division of Learning Services, 1979).

Kachru, Yamuna a. o., "Computer-based instruction in elementary Hindi", Studies in Language Learning, III (1981), 54-73.

Kalikow, D. N., Information processing models and computer aids for human performance. Task 1: Second-language learning (Arlington, Va.: Air Force Office of Scientific Research, 1972).

Kalikow, D. N. and A. M. Rollins, Information processing models and computer aids for human performance. Second language learning (Arlington: Air Force Office of Scientific Research, 1973).

Keller, H. H., "Vocabulary flashcards on the microcomputer", Russian Language Journal, XXXV (1981), 7-9.

Kenner, R. and G. Richards, "A home made package for use in the language lab", NALLD Journal, V (1980), 31-34.

Kenning, M. M. and M. Kenning, "Computer assisted language teaching made easy", British Journal of Language Teaching, XIX (1981), 119-123.

Kidd, E. M. and G. Holmes, "Strategies for change: The computer and language remediation", PLET, XIX (1982), 234-239.

Lane, H., "Programmed learning of a second language", in Glaser, R. E., Teaching machines and programmed learning: II, Data and directions (Washington, D. C.: National Education Association, 1965), pp. 584-646..

Langr, B. and A. R. Seybolt, "A computerized universal Spanish grammar drill program", in Theodore C. Willoughby, ed., Seventh conference on computers in the undergraduate curricula (Binghamton: State University of New York, 1976).

Last, R. W., "On-line computer assisted modern language teaching", Modern languages, LX (1979a).

Last, R. W., "The role of computer assisted learning in modern language teaching", ALLC Bulletin, VII (1979b).

Last, R. W. and P. K. King, "The design and implementation of a CAL package for modern language teaching: A research progress report", British jounal of educational technology, X (1979c), 194-197.

Last, R. W., "Computer assisted learning: Single element in total teaching process", Educational Computing, I (1980), 25-27.

Last, R. W., "From microphone to microchip: Technology in language teaching", Contact, n.vol., University of Dundee (1982), 54-59.

Lavine, R. Z. and S. A. Fechter, "Computer-assisted instruction in the ESL curriculum", Paper presented at the Conference of the Washington area teachers of English to speakers of other languages (Baltimore, MD: 2-3 October 1981).

Leidy, J., A. Merkel, A. Burke and M. Howard, "Using computer assisted instruction in an ESL language program", NALLD journal, XV (1980), 13-24.

Levine, D. R., "Computer-based analytic grading for German instruction", review in System, III, 3 (1975), 215-219.

Malkoc, Anna Maria, Programmed instruction in foreign languages: A selective listing of ERIC documents (Arlington: Educational Recources Information Center, 1971).

Manwell, T. a. o., "Tom Swift and his electric bilingual grandmother", ACM sigcue bulletin, VII (1973), 5-17.

Markle, S. Meyer, "Programmed instruction in English", in Glaser, R. E., Teaching machines and programmed learning: II, Data and directions (Washington, D. C.: National Education Association, 1965), pp. 546-583.

Markosian, Lawrence Z. and Tryg A. Ager, "Applications of parsing theory to computer-assisted instruction", System, XI (1983), 65-77.

Marty, F. and M. K. Myers, "Computerized instruction in second-language acquisition", Studies in Language Learning, I (1975), 22 pp.

Marty, F., "Reflections on the use of computers in second-language acquisition", System, IX (1981), 85-98.

Marty, F., "Reflections on the use of computers in second language acquisition - II", *System*, X (1982), 1-11.

McEwen, N., "Computer-assisted instruction in second-language learning: An Alberta project", *Canadian Modern Language Review*, XXXIII (1977), 333-343.

McKay, S., "Teaching the syntactic, semantic and pragmatic dimensions of verbs", *TESOL Quarterly*, XIV (1980), 17-26.

Merrill, M. David, Edward W. Schneider and Kathie A. Fletcher, *TICCIT*, The Instructional Design Library, vol. 40 (Englewood Cliffs, N.J.: Educational Technology Publications, 1980).

Morrison, H. W. and E. N. Adams, "Pilot study on CAI laboratory in German", *The Modern Language Journal*, LII (1968), 279-287.

Nelson, G. E., J. R. Ward, S. H. Desch and R. Kaplow, "Two new strategies for computer-assisted language instruction (CALI)", *Foreign Language Annals*, IX (1976), 28-37.

Olmsted, H. M., "Two models of computer-based drill: Teaching Russian with APL", *Slavic and East European journal*, XIX (1975), 11-29.

Olsen, S., "Foreign language departments and computer-assisted instruction: A survey", *Modern Language Journal*, LXIV (1980), 341-349.

Poulter, V. L., "Computer-assisted laboratory testing", *The Modern Language Journal*, LIII (1969), 561-564.

Pusack, J. P., *DASHER: A natural language answers processor* (Iowa City: Iowa Conduit, 1982a).

Pusack, J. P., "Answer-processing and error correction in foreign language CAI", *System*, II (1983).

Rosenbaum, P. S., "The computer as a learning environment for foreign language instruction", *Foreign Language Annals*, II (1969), 457-465.

Ross, L. and B. D. Sadler, "The teacher and the machine", *System*, II, 3 (1974), 7-9.

Ruplin, F. A. and J. R. Russell, "A type of computer-assisted instruction", *The German Quarterly*, XLI (1968), 84-88.

Sagvall-Brännström-Berghem, "MIR: A computer based approach to the acquisition of Russian vocabulary in context", *System*, IV (1976), 116-127.

Sanders, D. and R. Kenner, "Whither CAI? The need for communication courseware", *System*, XI (1983), 33-39.

Scanlan, R. T., "Computer-assisted instruction in foreign languages at the University of Illinois", *Foreign Language Annals*, IV (1971a), 423.

Scanlan, R. T., "Computer-assisted instruction: PLATO in Latin", *Foreign Language Annals*, V (1971b), 84-89.

Scanlan, R. T., "Computer-assisted instruction in Latin", *Foreign Language Annals*, XIII (1980), 53-55.

Scanlan, R. T., "Computer-assisted instruction in Latin and in English vocabulary development", *Studies in Language Learning*, III (1981), 113-22.

Schaeffer, R. H., "Meaningful practice on the computer: is it possible?", Foreign Language Annals, XIV (1981), 133-137.

Scherr, B. P. and L. W. Robinson, "Creating computer-assisted drills for Russian: The structure of the data base", Russian Language Journal, XXXIV (1980), 21-36.

Schneider, E. W. and J. L. Bennion, "Veni, vidi, vici, via videodisc : A simulation for instructional conversations", System, XI (1983), 41-46.

Séférian, M. A., "Lingua ex machina", System, IV (1976), 191-197.

Sherwood, B., "Computer processing of Esperanto text", Studies in Language Learning, III (1981a), 145-155.

Sherwood, B., "Speech synthesis applied to language teaching", Studies in Language Learning, III (1981b), 171-181.

Sherwood, J., "PLATO Esperanto materials", Studies in Language Learning, III (1981c), 123-128.

Shrimpton, N., "The use of a desk computer as a language teaching aid", System, I, 1 (1973), n.p.

Silberman, H. F., "Reading and related verbal learning", in Glaser, R. E., Teaching machines and programmed learning: II, Data and directions (Washington, D. C.: National Education Association, 1965), pp. 508-545.

Smith, Ph. D. Jr., "s2400, a computer-assisted instructional review of basic Spanish grammar", System, IV (1976), 182-190.

Stone, David E., Larry Israelite and Lois Wilson, "The TICCIT System", internal report, Brigham Young University, 1982.

Taylor, H. F., "Students' reactions to computer-assisted instruction in German", Foreign Language Annals, XII (1979), 289-291.

Taylor, H. F., "A self-evaluation of the individualized instruction program in German at the Ohio State University", Unterrichtspraxis, XV (1982), 4-13.

Taylor, J. H., "Details of score readout for students in practice mode", CTS Technical Report no. 5 (Provo, Utah: BYU Division of Learning Services, 1979).

Terry, R. M., "Students work with MONIQUE and learn French", Foreign Language Annals, XX (1977a), 191-197.

Terry, R. M., "MONIQUE: The assistante", Paper presented at the Annual Foreign Language Conference, Virginia (13-14 October 1977b).

Turner, R. C., "CARLOS: Computer-Assisted instruction in Spanish", Hispania, LIII (1970), 249-252.

Underwood, J., "Simulated conversation as a CAI strategy", Foreign Language Annals, XV (1982), 209-212.

Urion, K. U., CUM LAUDE: A new approach in designing computer-assisted language program, B.L. Thesis, Dartmouth College, 1970.

Ward, J. R., "Computer-driven tutorials on German word-order using the TICS computer subsystem", review in System, III, 3 (1975), 215-219.

Zoller, P., "Composition and the computer", System, II, 3 (1974), 3-6.